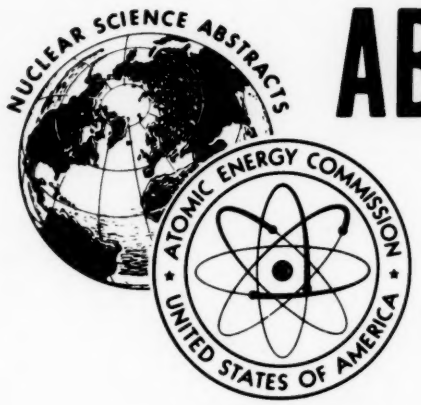
NUCLEAR SCIENCE ABSTRACTS



Volume 26 Number 9

Abstracts 19920-22548

May 15, 1972

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Volume 26, Number 9, May 15, 1972

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NEWLAND, E. A., Radiation treatment of sewage,  25:140
   (AAEC/LIB/Bib-254)
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    25:40 (IDO-12073, pp 28-36)
  separation by ion exchange and complex-formation elution,
    25:251(P)
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TRITIUM
  content in Cattaraugus Creek near West Valley Processing
    Plant, July through Dec. 1969,  25:258 (DOCKET-50201-
    48)
  content in Cattaraugus Creek near West Valley Processing
    Plant, Jan. to July 1970,  25:259 (DOCKET-50201-49)
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  Construction of a unique underground whole body counter,
    25:372 (UCRL-72739)
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Volume 26, Number 9 May 15, 1972

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 20771 and 20867.

19920 (CEA-R-4225) PREPARATION OF STANDARD SAMPLES: IMPURITIES IN PLUTONIUM OXIDE. (Institut National des Sciences et Techniques Nucleaires, Saclay (France). Commission d'Etablissement des Methodes d'Analyse). Nov 1971. 23p. (In French). Dep. NTIS (U. S. Sales Only).

Six plutonium oxide samples containing known quantities of impurities were prepared by mixing a powder containing about twenty elements with plutonium oxide obtained from the oxidation of very pure metal. Many precautions were taken to ensure freedom from contamination and homogeneity. Measurements effected in several laboratories led to the determination of the most probable contents of sixteen different elements. The experimental knowledge acquired has made the large scale preparation of samples possible, and it is expected that the needs of analytical laboratories will be satisfied during several years to come. (France)

19921 (NBL-262) ANNUAL PROGRESS REPORT FOR THE PERIOD JULY 1970-JUNE 1971. (New Brunswick Lab. (AEC), N. J.). Jan 1972. 85p. Dep. NTIS.

Progress on analytical procedures is reported in 21 sections. An abstract was prepared for each. (M.C.G.)

For abstracts of individual sections see: 19945-19961, 20010-20012, and 20023.

19922 DEVELOPMENT OF ANALYTICAL CHEMISTRY IN 1969 (REVIEW). Pilipenko, A. T. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 6, 821-41(Jun 1971).

Translated from Zavod. Lab.; 37: No. 6, 641-58(Jun 1971).

A review of the development of analytical chemistry in 1969 is presented in which basic new data on the chemical reactions, method, and procedures used in the analysis of inorganic substances are discussed. (295 references) (D.H.M.)

Activation and Nuclear Reaction Procedures

Refer also to abstracts 20426 and 20515.

19923 (AE-396) NEW BORON ANALYSIS METHOD. Weitman, J.; Daverhoeg, N.; Farvolden, S. (Aktiebolaget Atomenergi, Studsvik (Sweden)). 1970. 25p. Dep. NTIS (U. S. Sales Only).

In connection with fast neutron (n,α) cross section measurements a boron analysis method was developed. The boron concentration is inferred from the mass spectrometrically determined number of helium atoms produced in the thermal and epithermal $^{10}B(n,\alpha)$ reaction. The relation between helium amount and boron concentration is given, including corrections for self-shielding effects and background levels. Direct and diffusion losses of helium are calculated and losses due to gettering, adsorption, and ionization in the release stage are discussed. A series of boron determinations is described and the results are compared with those obtained by other methods, showing excellent agreement. The lower limit of boron concentration that can be measured varies with type of sample. In steel, for example, concentrations below 10^{-5}% boron in samples of 0.1 to 1 gram may be determined. (auth)

19924 (RCN-155) DETERMINATION OF MANGANESE, COPPER, AND IRON IN HUMAN BLOOD BY NEUTRON ACTIVATION ANALYSIS. Das, H. A.; Hoede, D.; Kroon, J. J.; Zonderhuis, J. (Reactor Centrum Nederland, Petten). Sep 1971. 20p. Dep. NTIS (U. S. Sales Only).

Procedures for the determination of manganese, copper and iron in blood are given. Manganese and copper were determined by thermal neutron activation, followed by chemical separation. The iron concentration was obtained by instrumental fast neutron activation analysis. (auth)

19925 (WSUNRC-97(2)) GAMMA RAY ENERGY TABLES FOR NEUTRON ACTIVATION ANALYSIS. Filby, R. H.; Davis, A. I.; Shah, K. R.; Wainscott, G. G.; Haller, W. A.; Cassatt, W. A. (comps. and eds.) (Washington State Univ., Pullman. Nuclear Radiation Center). 1970. 205p.

Gamma energy and intensity data for isotopes formed by (n,γ) reactions are listed. Energies are expressed in keV and are given to ±0.1 keV. Absolute as well as relative intensities are given. Radioactive daughter nuclides, if they emit γ rays, are indicated and included in the tables. The tables include: γ rays ordered by increasing energy, nuclides listed by atomic number, and nuclides listed by increasing half-life. (M.C.G.)

19926 INTERPRETATION OF ERRORS IN COUNTING EXPERIMENTS. Currie, Lloyd A. (Univ., Bern. National Bureau of Standards, Washington, D. C.). Anal. Lett.; 4: No. 12, 873-82 (Dec 1971).

Digital experiments, such as the measurement of radioactivity, are usually characterized by random errors which follow the binomial or Poisson distribution. Three types of difficulty that commonly arise in the statistical treatment of such experiments include: (a) failure to recognize that the uncertainty in the physical quantity of interest may be governed by a compound probability distribution, particularly when dealing with shortlived radioactivity; (b) the improper use of the chi-squared statistic when making standard error estimates in weighted least-squares calculations; (c) selecting the correct number of degrees of freedom and choosing between the χ^2 dispersion test and the goodness-of-fit test for grouped data. Examination of the nature of each of these difficulites has been followed by a recommended course of action. (auth)

19927 INVESTIGATION OF THE DISTRIBUTION OF IMPURITIES IN A SEMICONDUCTING THERMOELECTRIC MATERIAL BY A RADIOACTIVE METHOD. Kazakevich, V. I.; Polistanskii, Yu. G.; Babikova, Yu. F.; Minaev, V. M. (Moscow Engineering-Physics Inst.). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 7, 1028-9(Jul 1971).

Translated from Zavod. Lab.; 37: No. 7, 805-6(Jul 1971).

The nature of the distribution and diffusion mobility of impurities in the structure of a material was investigated using activation autoradiography. The autoradiogram characterizing the distribution of sodium in lead telluride was obtained by the activation of sodium by deuterons, $^{23}Na(d,p)^{24}Na$ reaction. The distribution of lithium in lead telluride was studied by proton irradiation resulting in the $^{7}Li(p,n)^{7}Be$ reaction. (D.H.M.)

19928 DETERMINATION OF LITHIUM IN SOLID MATERIALS BASED ON REACTION $^{6}Li(n,\alpha)^{3}H$. Zverev, B. P.; Simakhin, Yu. F.; Dutov, A. G. At. Energ. (USSR); 32: No. 1, 39-42(Jan 1972). (In Russian).

Nondestructive lithium determination in solid materials with

the help of any convenient material standards is described. The content of lithium is determined by detection of tritons produced in the $^{6}Li(n,\alpha)^{3}H$ reaction with thermal neutrons from a horizontal reactor channel. A CsI(Tl) crystal with a diameter of 30 mm and the thickness of 20 to 30 μm is used to detect tritons. Separation of the triton spectrum from the spectrum of charged particles produced in fast neutron-induced reactions is made by subtraction with use of the thermal neutron beam modulation method. The sensitivity of determination of lithium is 10^{-4} to 5×10^{-5}% and depends on sample surface and measurement time. The results of lithium determination in natural quartz are presented. (auth)

19929 DETERMINATION OF MOLYBDENUM IN ROCKS BY EPITHERMAL NEUTRON ACTIVATION ANALYSIS. Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Anal. Chim. Acta; 57: No. 2, 249-55(Dec 1971).

A neutron-activation method for molybdenum in rocks based on epithermal activation and a simple radiochemical separation is described, and data for some standard rocks are presented. Errors caused by fission of uranium and thorium in neutron activation for molybdenum are calculated and discussed. The interference from fission product ^{99}Mo is shown to be considerably dependent on the epithermal and the fast-neutron flux. Epi-cadmium activation reduces the uranium interference by a factor of 20 to 80 compared to activation without cadmium cover, the actual value being dependent on the cadmium ratio of gold in the irradiation position used. (auth)

19930 DETERMINATION OF LEAD IN BIOLOGICAL MATERIALS BY HIGH-ENERGY GAMMA-PROTON ACTIVATION. Hislop, J. S.; Williams, D. R. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Analyst; 97: No. 1150, 78(Jan 1972).

Brief notes are presented on the use of high-energy γ-photon activation for the determination of lead in kale, orchard leaves, and human bone ash. Irradiations were carried out for two hours in the bremsstrahlung produced from 5 μA of 35- to 40-MeV electrons, using the Harwell Linac. The technique produced ^{203}Pb or ^{204m}Pb with γ emission, and this was separated radiochemically from the majority of the activity produced in these calcium-rich materials by the $^{44}Ca(\gamma,p)^{43}K$ and $^{46}Ca(\gamma,n)^{45}Ca$ reactions. The limit of detection was approximately 0.1 μg. (UK)

19931 USE OF THE LUMINESCENCE OF CRYSTAL PHOSPHORS FOR QUANTITATIVE DETERMINATION OF TRACES OF RARE EARTH ELEMENTS. Antonov, A. V.; Kulevskii, L. V.; Melamed, Sh. G. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 5, 658-660(May 1971).

Translated from Zavod. Lab., 37: No. 5, 518-21(May 1971).

The use of the luminescence of crystal phosphors for determining traces of rare earth metals is discussed. Thus crystal phosphors of the $Ln_2O_3 \cdot Ln$ (Ln = lanthanide element: Yt, La, etc.) type yield a strong luminescence, the intensity of this being directly related to the proportion of Ln present. Examples are given for the case of Tb in the phosphors $Yt_2O_3 \cdot Tb$ and $La_2O_3 \cdot Tb$. Excitation may be effected either by a light beam or by a beam of electrons in a demountable cathode-ray tube. The sensitivity is 10 times as great in the case of photo-excitation. (Metals Abstr.)

19932 NEUTRON ACTIVATION: A METHOD FOR THE DETECTION OF APATITE AND OTHER FLUORINE-CONTAINING MINERALIZATIONS ACCORDING TO FLUORINE DISPERSION AUREOLES. Gorbatschev, A. N.; Karpunin, A. M.; Matukanis, L. F. Z. Angew. Geol.; 17: No. 10, 436-8(Oct 1971). (In German).

The fluorine content of geological formations was studied by neutron activation analysis. Neutrons were produced by a polonium-beryllium source of either 5 or 10 curies. Gamma radiation from the reaction $^{19}F(n,\alpha)^{16}N$ was measured with a portable scintillation spectrometer in the integral as well as in the differential mode of operation. With respect to sensitivity, neutron activation corresponded to the chemical analysis for fluorine and phosphorus; however, the first method was much more rapid. The studies revealed feasibility of fluorine determination in the field by neutron activation methods. (H.B.G.)

19933 DETERMINATION OF PHOSPHORUS IN SILICATE ROCKS BY NEUTRON ACTIVATION AND DIRECT β-COUNTING. Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Anal. Chim. Acta; 57: No. 2, 451-6(Dec 1971).

A method for determining phosphorus in silicate rocks by neutron activation and direct β counting is presented that is considered well suited for rocks with phosphorus contents exceeding 500 ppM. Rubidium is the most serious interference and the accuracy of the results depends on a fairly good knowledge of the rubidium content. For calcium an approximate knowledge of the content suffices in most cases. (D.H.M.)

19934 CONDITIONS FOR THE SELECTIVE ACTIVATION OF ALUMINUM IN THE PRESENCE OF SILICON BY MEANS OF Pu-Be SOURCE. Belyakov, M. A.; Anchevskii, E. V.; Terent'ev, E. P. (State Scientific-Research Inst. for Chemical Minerals, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 5, 724-5(May 1971).

Translated from Zavod. Lab., 37: No. 5, 567-8(May 1971).

Problems arising in connection with the determination of Al in ores and alloys by the activation method based on Pu-Be or Po-Be neutron sources are discussed. Thus the determination is almost always impeded by the presence of Si, which undergoes reactions masking those of Al. However, by judiciously choosing the degree of Al activation, e.g., halving the activation normally employed, the effect of Si may be substantially reduced, e.g., the error in Al determination may be reduced from 15 to 0.5%. (Metals Abstr.)

19935 APPLICATION OF LOW-ENERGY PROTON ACTIVATION TO THE DETERMINATION OF LIGHT ELEMENTS. Dzemard'yan, Yu. A.; Mikhailov, G. I.; Starchik, L. P. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 5, 708-13(May 1971).

Translated from Zavod. Lab., 37: No. 5, 555-60(May 1971).

The use of nuclear reactions initiated by low-energy (<1-MeV) protons in order to determine light elements (Li, Na, Mg, Al, Si, and others with atomic number below 17) is described. The analysis is based on measuring the yield of γ radiation from the (p,γ) and (p,α,γ) reactions or the heights of the resonance steps exhibited on the yield curves. Several elements may be determined simultaneously by applying matrix analysis to the observed γ spectra. The sensitivity is 10^{-2} to 10^{-3}% and the error 15%. (Metals Abstr.)

19936 COMPARATIVE STUDIES ON THE CONCENTRATION OF VARIOUS TRACE ELEMENTS IN SPECIFIC AREAS OF THE HUMAN BRAIN USING NEUTRON ACTIVATION ANALYSIS. Henke, G.; Moellmann, H.; Alfes, H. (Univ., Muenster, Ger.). Z. Neurol.; 199: 283-94(1971). (In German).

The concentrations of Cu, Se, Ag, Zn, Fe, Rb, Au, La, and Ba were determined in 14 areas of the human brain by neutron activation analysis. The concentrations of these elements were higher in the centers of extra-pyramidal motor activity than in the areas primarily consisting of white matter. The results are discussed and compared to work hitherto published. (auth)

19937 METHOD OF DETERMINING THE COMPOSITION OF A STEEL MELT AND APPARATUS FOR PERFORMING THE METHOD. Mitsche, Roland; Higatsberger, Michael J.; Viehbock, Franz; Rumpold, Karl (to Osterreichische Studiengelleschaft fuer Atomenergie GmbH). British Patent 1,263,559. 9 Feb 1972. Priority date 27 May 1968, Austria.

A method and apparatus for determining the composition of a steel melt by bombardment of the melt intermittently for very short periods with neutrons are described. The neutrons have discrete energy levels that correspond to a resonance level of the nuclei of the element to be tested. Prompt γ radiation emitted by the excited or intermediate nuclei is used for the characterizing analysis. (M.C.G.)

19938 ACTIVATION ANALYSIS OF BIOLOGICAL MATERIALS. Yamada, Yoshio (Kyushu Univ., Fukuoka). Radioisotopes (Tokyo); 20: No. 8, 385-93(Aug 1971). (In Japanese).

A review on the use of activation analysis of biological materials is presented that includes the management of materials, care to contamination with dust, washing in sampling and preparation of materials for analysis, selection of sampling device, and the necessity for pretreatment and its method. A discussion is given of chemical separation as to whether separation should be conducted before or after activation and the criteria for the selection of the isolation method. A brief account of some major isolation methods such as distillation method, solvent extraction method, chromatography and precipitation method is also provided. Application of activation analysis to soil science and biochemistry reported in a symposium on Activation Analysis in Biological Science sponsored by IAEA in 1967, comparison of sensitivity with other conventional methods in the analysis of various elements in animal tissues, studies on the metabolism of microelements by activable tracer, and application to public health and industrial hygiene are introduced. Results of five studies on the comparative experiments of activation analysis and other methods are summed up, with a major emphasis on the study of a combined use of nondestructive analysis and chemical isolation in the analysis of various elements contained in plants as an example of practical application. Topics reviewed in the application to medicine in the last five years include: analysis of blood, tumor tissue, food, drinking water and human excreta; quantitative determination of free serum thyroxine, analysis of Sr and Ba in human plasma, Br in human tissues, As in human nails and hair, and Cl

contained in rice oil for the study of materials causing Yusho (chlorobiphenyl poisoning). The survival time of red blood cells was examined with an activable tracer technique using ^{50}Cr. Besides activation analysis by the nuclear reaction (n,γ), bremsstrahlung or neutrons are used in the analysis of various intracorporeal elements. (Japan)

19939 APPLICATION OF HIGH RESOLUTION X-RAY SPECTROMETRY TO ACTIVATION ANALYSIS. Mantel, Marianna; Amiel, Saadia (Soreq Nuclear Research Centre, Yavne, Israel). Anal. Chem.; 44: No. 3, 548-53(Mar 1972).

High resolution x-ray spectrometry was applied to neutron activation analysis. The feasibility of applying this method to all naturally occurring elements was investigated. Thirty elements were studied experimentally ($27 \leq Z \leq 92$). The detection sensitivity for these elements ranged from 10^5 to 10^{-2} dps/μg, using 5-minute neutron irradiations at a flux of 10^{13} neutrons/cm^2 sec and employing a 1% or 4% counting geometry. Resolutions of 320 eV obtainable with the Si(Li) detectors make possible the simultaneous determination of neighboring elements in most cases. Several practical examples are given to demonstrate some of the advantages of x-ray over gamma-ray spectrometry in activation analysis. (auth)

19940 DETERMINATION OF TRACE CONCENTRATION OF BORON AND URANIUM IN GLASS BY THE NUCLEAR TRACK TECHNIQUE. Carpenter, B. Stephen (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 44: No. 3, 600-2(Mar 1972).

A method for determining boron and uranium in glass by the nuclear track technique is presented based on the thermal neutron reaction $^{10}B(n,\alpha)^7Li$ and the $^{235}U(n,f)$ reaction in Lexan polycarbonate. The latent tracks were made optically visible by chemically etching the detectors and absolute measurements, rather than the standard-comparator method, were used to determine the elements. Since the random fields of view taken reflect only a minute portion of the total sample, the precision of the results given was ±10%. (D.H.M.)

19941 DETERMINATION OF MERCURY IN SEAWATER BY RADIOACTIVATION. Weiss, Herbert V. (Naval Undersea Research and Development Center, San Diego, Calif.); Crozier, Thomas E. Anal. Chim. Acta; 58: No. 1, 231-3(Jan 1972).

A neutron activation method for determining mercury in seawater was developed that involves isolating the mercury from seawater before irradiation by coprecipitation with copper sulfide, irradiation with 2×10^{12} n · cm^{-2} · sec^{-1} neutrons, radiochemical separation, and counting of ^{197}Hg. (D.H.M.)

19942 PRECONCENTRATION TECHNIQUES FOR TRACE ANALYSIS VIA NEUTRON ACTIVATION. Rottschafer, J. Mark (Univ. of Michigan, Ann Arbor); Boczkowski, Ronald J.; Mark, Harry B. Jr. Talanta; 19: No. 2, 163-72(Feb 1972).

A review is given of the methods that have been proposed for enrichment of trace elements in samples that are to be analyzed by neutron-activation methods. The emphasis is on classification of methods, with illustrations by means of practical examples. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 20046, 20520, 20522, 20526, 20528, 20529, and 22150.

19943 (BARC-570) X-RAY FLUORESCENCE ANALYSIS OF ACTINIDE ELEMENTS IN SOLUTION. Dias, R. M. A.; Chawla, K. L.; Jayadevan, N. C.; Chackraburtty, D. M. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 25p. Dep. NTIS (U. S. Sales Only).

The feasibility of the application of an x-ray fluorescence method for the estimation of uranium, plutonium, and fission products in process solution was investigated. Using both chromium and molybdenum targets estimation of uranium and thorium in nitric acide solutions was studied in the concentration range of 0.0001 to 5 mg/ml. Plutonium solutions in the concentration ranges encountered in the process solutions were also studied. The results show that the method is rapid and reproducible with a high precision with a standard deviation of 0.1 to 0.9% in the concentration ranges studied. (auth)

19944 (LA-4849) DETERMINATION OF $^{18}O/^{16}O$ ATOM RATIO IN PLUTONIUM DIOXIDE ENRICHED IN ^{16}O. MacDougall, Carolyn S.; Smith, Maynard E.; Waterbury, Glenn R. (Los Alamos Scientific Lab., N. Mex.). Feb 1972. Contract W-7405-eng-36. 9p. Dep. NTIS.

Mass spectrometry is used to measure the $^{18}O/^{16}O$ atom ratio in plutonium dioxide enriched in ^{16}O isotope, after the oxygen was separated as carbon monoxide by reacting the refractory oxide with carbon at 2000°C in an inductively heated graphite crucible. The carbon monoxide is trapped on silica gel that is cooled in liquid nitrogen and is separated from any nitrogen present on a gas chromatographic column before being analyzed in a mass spectrometer. The $^{18}O/^{16}O$ atom ratio is calculated from the ratio of the $^{12}C^{18}O$ to $^{12}C^{16}O$ peak heights. As plutonium oxide standards having known $^{18}O/^{16}O$ atom ratios were not available, the mass spectrometric method was tested by comparing the measured $^{18}O/^{16}O$ atom ratios with results obtained from neutron-count analyses that indicated the approximate maxima for these ratios. The results from both methods were generally about equal and, more important, the mass spectrometric results were always lower than the maxima indicated by the neutron counts. At an $^{18}O/^{16}O$ ratio of 5×10^{-5}, the standard deviation of the method was 5×10^{-6}. This method, which should apply equally well to any oxide that yields carbon monoxide upon reaction with carbon at 2000°C was applied to the measurement of ^{18}O in plutonium oxides in which the ^{238}Pu enrichment was 80% or greater and in various cladding materials surrounding these plutonium oxides. (auth)

19945 (NBL-262, pp 5-16) HIGH-PRECISION DETERMINATION OF TOTAL URANIUM, URANIUM(IV), AND URANIUM(VI) IN U_3O_8-ANALYSES OF NATIONAL BUREAU OF STANDARDS 950a U_3O_8 AFTER IGNITION AT VARIOUS TEMPERATURES. Eberle, A. R.; Lerner, M. W. (New Brunswick Lab. (AEC), N. J.).

The high-precision modification of the titrimetric method of determining uranium was applied to the determination of total uranium and uranium(IV) in U_3O_8. The uranium(VI) content can also be obtained by a similar procedure. The effect of ignition temperature on the total uranium and the uranium(IV)/total uranium and uranium(VI)/total uranium ratios in NBS 950a U_3O_8 was determined. (auth)

19946 (NBL-262, pp 17-19) AUTOMATIC INSTRUMENT FOR THE NEW BRUNSWICK LABORATORY TITRIMETRIC METHOD OF DETERMINING URANIUM: AN 18-MONTH EVALUATION. Clickner, M. R.; Goldbeck, C. G.; Lerner, M. W. (New Brunswick Lab. (AEC), N. J.).

The performance of an automatic uranium analyzer over an 18-month period was evaluated. General modifications in the original instrument, maintenance problems, and the reliability as shown by analyses of control standards are discussed. (auth)

19947 (NBL-262, pp 20) DETERMINATION OF URANIUM IN URANIUM-THORIUM SOLUTIONS BY THE NEW BRUNSWICK LABORATORY TITRIMETRIC METHOD. Eberle, A. R.; Lerner, M. W. (New Brunswick Lab. (AEC), N. J.).

The reliability of determining uranium in uranium–thorium mixtures (1 U : 5 Th) by the NBL titrimetric method was evaluated. The relative standard deviation is 0.07% and the accuracy (relative difference) is -0.03 ± 0.07% (95% C.L.). (auth)

19948 (NBL-262, pp 21-4) ELIMINATION OF INTERFERENCE OF MANGANESE IN THE NEW BRUNSWICK LABORATORY TITRIMETRIC METHOD OF DETERMINING URANIUM. Eberle, A. R.; Lerner, M. W. (New Brunswick Lab. (AEC), N. J.).

The interference of manganese in the NBL titrimetric method of determining uranium can be overcome by fuming the sample with sulfuric, perchloric, or phosphoric acid before the analysis. (auth)

19949 (NBL-262, pp 25-9) COMPARISON OF PREPARED AND STANDARDIZATION VALUES FOR THE TITER OF POTASSIUM DICHROMATE. Pietri, C. E.; Wenzel, A. W.; Simmons, H. N. (New Brunswick Lab. (AEC), N. J.).

Potassium dichromate titrant was studied over the past several years from the standpoint of possible differences in the calculated titer (determined from the weight and purity of the dichromate in the solution) and the titer obtained by standardization with primary or secondary standards of uranium and plutonium. No significant differences were found. (auth)

19950 (NBL-262, pp 30-4) EVALUATION OF THE AMPEROMETRIC-TITRATION PROCEDURE FOR DETERMINING PLUTONIUM: A PROGRESS REPORT. Lewis, K. (New Brunswick Lab. (AEC), N. J.).

The amperometric method of determining plutonium involving the oxidation to plutonium(VI) with argentic oxide and titration with ferrous ion was evaluated. The relative standard deviations obtained ranged from 0.07 to 0.16%. The relative errors were appreciably higher. One cause of the large errors was traced to an oxidizable impurity in the sulfuric acid diluent. (auth)

19951 (NBL-262, pp 35-7) STABILIZATION OF FERROUS SULFATE TITRANT SOLUTION: A PROGRESS REPORT. Hedrick, C. E. (New Brunswick Lab. (AEC), N. J.).

Attempts were made to improve the stability of ferrous ion titrant. The most promising results were obtained by the addition of sulfamic acid to the ferrous solution. (auth)

19952 (NBL-262, pp 38-40) BRIEF STUDY ON THE DETERMINATION OF FREE ACIDITY IN CERIC AMMONIUM NITRATE SOLUTIONS. Wenzel, A. W.; Pietri, C. E. (New Brunswick Lab. (AEC), N. J.).

The usefulness of a ceric ammonium nitrate solution to serve as a simulated plutonium(IV) solution for the determination of acidity by two different methods, iodate precipitation and citrate complexation, was evaluated. Accurate results were not obtained with this material by either method. The citrate complexation method was found to give progressively lower results when the standing time between complexation and titration was increased. (auth)

19953 (NBL-262, pp 43-6) EFFECT OF HUMIDITY ON LOW-FIRED PLUTONIUM OXIDE SAMPLES. Wenzel, A. W.; Simmons, H. N.; Duke, J. L.; Pietri, C. E. (New Brunswick Lab. (AEC), N. J.).

Some experiences with analysis of low-fired hygroscopic plutonium oxide samples are described. Recommendations regarding packaging of this type of material are made, and the need for an interlaboratory comparison study is pointed out. (auth)

19954 (NBL-262, pp 47-9) PACKAGING PLUTONIUM METAL, ALLOY, AND OXIDE ANALYTICAL SAMPLES FOR OFFSITE SHIPMENT. Wenzel, A. W.; Simmons, H. N.; Pietri, C. E. (New Brunswick Lab. (AEC), N. J.).

Analyses of plutonium–aluminum alloy and plutonium oxide samples packaged either in plastic vials with snap-on caps or in sealed tubes for shipment indicated that sample integrity is best preserved in sealed tubes. (auth)

19955 (NBL-262, pp 50-1) MODIFIED AMPEROMETRIC METHOD OF DETERMINING PLUTONIUM. Hedrick, C. E.; Pietri, C. E.; Wenzel, A. W.; Lerner, M. W. (New Brunswick Lab. (AEC), N. J.).

In the amperometric determination of plutonium by oxidation with argentic oxide to plutonium(VI) followed by titration with ferrous ion, it was found that the interference of chromium, manganese, and cerium could be eliminated by reduction of the oxidized state of these elements with arsenious oxide and osmium catalyst before the final titration. (auth)

19956 (NBL-262, pp 52-5) DETERMINATION OF URANIUM IN NATURAL WATERS BY ELECTRICAL-DETECTION SPARK-SOURCE MASS SPECTROMETRY. Callis, E. L. (New Brunswick Lab. (AEC), N. J.).

A method was developed for determination of uranium at concentration levels as low as 0.02 μg/l in natural waters by spark-source mass spectrometry with electrical detection. Impurities in a water sample are incorporated into a bismuth oxide matrix and the $^{238}U/^{209}Bi$ ratio is measured with the mass spectrometer. The accuracy of the method is on the order of ±5%. (auth)

19957 (NBL-262, pp 56-8) EXTENSION OF THE REFRACTORY CARRIER-LAYER METHOD TO THE DETERMINATION OF OTHER ELEMENTS IN URANIUM. Yuster, H. G. (New Brunswick Lab. (AEC), N. J.).

A recently proposed spectrochemical method of determining refractories in uranium by the use of a carrier-layer technique was extended to the determination of Fe, Ni, Mn, Cu, and Al. The relative merits of the method are discussed. (auth)

19958 (NBL-262, pp 59-61) SPECTROCHEMICAL DETERMINATION OF IMPURITIES IN ALUMINUM–URANIUM ALLOYS. Yuster, H. G.; Graff, R. L. (New Brunswick Lab. (AEC), N. J.).

A spectrochemical method was developed for determining impurities in aluminum–uranium alloys. By use of a gallium fluoride–graphite buffer and complete burning of the sample, no preliminary conversion to oxide is necessary. The results obtained with samples are compared to those obtained by atomic absorption spectrophotometry. (auth)

19959 (NBL-262, pp 62-4) ATOMIC ABSORPTION SPECTROPHOTOMETRIC DETERMINATION OF SILICON IN BORON AND BORON CARBIDE. Graff, R. L.; Yuster, H. G. (New Brunswick Lab. (AEC), N. J.).

The existence of some uncertainty in the silicon values in boron materials obtained by emission spectrography prompted the analysis of several samples of boron and boron carbide by atomic absorption spectrophotometry as well as emission spectrography. Some differences in results were obtained. (auth)

19960 (NBL-262, pp 75-7) EVALUATION OF A COMMERCIAL GRAVIMETRIC PIPETTER FOR DISPENSING CONTROL STANDARD SOLUTIONS. Pinto, L. J.; Pietri, C. E. (New Brunswick Lab. (AEC), N. J.).

A commercially available gravimetric titrator was evaluated for use in dispensing aliquots of standard solutions. When 10-g or larger aliquots are dispensed, the precision and accuracy of delivery is adequate for quality control of NBL high-precision uranium and plutonium assay methods. (auth)

19961 (NBL-262, pp 78-82) CALIBRATION OF THE OAK RIDGE NATIONAL LABORATORY MODEL Q-1348C REMOTE PIPETTER FOR HOT CELL WORK. Pinto, L. J.; Pietri, C. E.; Jacob, E. H. (New Brunswick Lab. (AEC), N. J.).

The performance of the ORNL Model Q-1348C remote pipetter with 1.2-ml capacity was evaluated. On the basis of the precision and accuracy of deliveries, the instrument appeared to be satisfactory for use at this laboratory only for dispensing aliquots between 0.5 and 1.0 ml. (auth)

19962 CATHODIC STRIPPING VOLTAMMETRY OF CERIUM. Dolezal, J.; Hrabankova, E.; Masin, V. (Charles Univ., Prague). Anal. Lett.; 4: No. 12, 887-92(Dec 1971).

The experimental conditions for the accumulation of cerium as insoluble $Ce_3(PO_4)_4$ on a platinum indicator electrode were studied. The determination of cerium down to 0.01% in oxides of other lanthanides is described. (auth)

19963 DETERMINATION OF SMALL QUANTITIES OF SULFUR IN SELENIUM, TELLURIUM, COPPER, AND NICKEL BY ALTERNATING-CURRENT POLAROGRAPHY. Vasil'eva, L. N.; Pats, R. G.; Yustus, Z. L.; Semochkina, T. V. (State Scientific-Research Inst. of Nonferrous Metals, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 7, 973-6(Jul 1971).

Translated from Zavod. Lab.; 37: No. 7, 762-5(Jul 1971).

A polarographic method was developed for the determination of 10^{-4} to 10^{-6}% of sulfur in selenium, tellurium, copper, and nickel using the main sulfide ion current observed at a potential of −0.7 V. A method for separating selenium and tellurium with hydrazine was used in determining sulfur in tellurium or selenium; however, no separation step was necessary in the determination of sulfur in copper and nickel. (D.H.M.)

19964 CHEMICAL-SPECTRAL DETERMINATION OF IMPURITIES IN HIGH-PURITY CADMIUM. Ustimov, A. M.; Tember, G. A.; Chalkov, N. Ya. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 6, 845-7(Jun 1971).

Translated from Zavod. Lab., 37: No. 6, 660-2(Jun 1971).

A chemical–spectral method was developed for determining concentrations of from 1×10^{-5} to 5×10^{-7}% in cadmium of the following: Al, Co, Ca, Fe, Bi, In, Ga, Mg, Na, Ni, Sb, Pb, Sn, and Zn. The concentrating method is based on separating the main mass of the cadmium from the impurities by extracting the cadmium in the form of a pyridine–iodide complex with chloroform. (D.H.M.)

19965 CONCENTRATION OF TRACE ELEMENTS IN THE ANALYSIS OF ARSENIC TRICHLORIDE. Kuzmin, N. M.; Popova, G. D.; Sabatovskaya, V. L. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 6, 842-4(Jun 1971).

Translated from Zavod. Lab.; 37: No. 6, 658-60(Jun 1971).

A highly sensitive method is proposed for the determination of 18 elements (Au, Ag, Al, Ba, Bi, Ca, Co, Cr, Cu, Fe, Ga, In, Mg, Mn, Ni, Sb, Te, and Zn) in arsenic trichloride based on the extractive separation of major elements from trace elements with the hydrochloric acid–m-xylene system and analysis of the concentrated mixture of trace elements using dissociation in the hollow cathode. (D.H.M.)

19966 CONCENTRATING MICROIMPURITIES WITH A PART OF THE BASE METAL DURING SPECTRAL ANALYSIS OF HIGH-PURITY CADMIUM AND ZINC. Tiptsova-Yakovleva, V. G.; Dvortsan, A. G. (Moscow Inst. of Steel and Alloys). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 6, 867-70(Jun 1971).

Translated from Zavod. Lab.; 37: No. 6, 676-9(Jun 1971).

A method of group concentration by coprecipitation with inorganic collectors was developed that permits an easy preparation of a concentrate for spectral analysis with simultaneous reduction of the volume of the base materials. The method is very convenient for concentration of impurities that can be precipitated in the form of scarcely soluble hydroxides (Cu^{2+}, Ni^{2+}, Pb^{2+}, Bi^{3+}, Ga^{3+}, In^{3+}, etc.) or salts with zinc or cadium (AsO_4^{3-}, TeO_3^{2-}, and SbO_3^{-}). (D.H.M.)

19967 ATOMIC ABSORPTION METHODS FOR MATERIALS ANALYSIS IN THE NON-FERROUS METALS INDUSTRY. Jedrzejewska, Helena; Jedrzejewski, Stanislaw. Rudy Metale Niezelaz.; 16: No. 10, 487-9(Oct 1971). (In Polish).

The application of atomic absorption spectrophotometry for analysis of nonferrous ores, semiproducts, metals, and alloys is described. Physical and spectral interference encountered is discussed and methods of determining parameters for absorption measurements are given. (auth)

19968 PHOTOMETRIC DETERMINATION OF TIN IN INTERMETALLIC COMPOUNDS AND ALLOYS WITH NIOBIUM AND ZIRCONIUM. Elinson, S. V.; Tsvetkova, V. T. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 6, 848-50(Jun 1971). Translated from Zavod. Lab.; 37: No. 6, 662-4(Jun 1971).

A photometric method for determining tin in the presence of niobium and zirconium was developed based on the $Sn-Fe^{2+}$–dimethylglyoximate complex. A number of zirconium-based alloys containing 1 to 3% Sn and also 1 to 5% Nb and Fe were analyzed. A niobium-base alloy with a nominal tin content of 29.87% was also analyzed. The mean square error from ten determinations was ±0.08 and the variation factor was ±0.3%. (D.H.M.)

19969 GAS-CHROMATOGRAPHIC DETERMINATION OF ULTRAMICRO AMOUNTS OF SELENIUM IN PURE TELLURIUM METAL. Shimoishi, Yasuaki (Okayama Univ., Japan). Bull. Chem. Soc. Jap.; 44: No. 12, 3370-2(Dec 1971).

Selenium(IV) reacts with 4-nitro-o-phenylenediamine to form 5-nitropiaselenol, which is detected by means of a gas chromatograph equipped with an electron-capture detector. By this highly sensitive method, the selenium in pure tellurium (99.9 to 99.999%) can easily be determined. Aqua regia oxidizes both selenium and tellurium to the quadrivalent state, and no less of selenium is found on this treatment. This method requires only 10 to 30 mg of a tellurium sample, and the presence of foreign ions does not interfere. It was found that pure tellurium, commercially available, always contains 10^{-3} to 10^{-4}% selenium. (auth)

19970 POLAROGRAPHIC DETERMINATION OF METAL IONS WITH RESACETOPHENONE OXIME VIA SOLVENT EXTRACTION. Rao, S. Brahmaji; Rao, P. Mangeshwara (Sri Venkateswara Univ., Tirupati, India). Curr. Sci. (India); 41: No. 4, 156-7(20 Feb 1972).

The use of resacetophenone oxime for the polarographic determination of metal ions, including U(VI), via solvent extraction with n-butanol was investigated. Linear calibration curves for given concentration ranges were obtained. Interfering elements are tabulated. (J.G.B.)

19971 DETERMINATION OF SUBMICROGRAM AMOUNTS OF IODIDE BY ITS CATALYTIC EFFECT ON THE SUBSTITUTION REACTION OF MERCURY(II)-PAR COMPLEX WITH CyDTA. Funahashi, Shigenobu; Tabata, Masaaki; Tanaka, Motoharu (Nagoya Univ., Japan). Anal. Chim. Acta; 57: No. 2, 311-15 (Dec 1971).

A kinetic method for the determination of submicrogram amounts of iodide is described. The method is based on the catalytic effect of iodide on the ligand substitution reaction of the mercury(II)–4-(2-pyridylazo)resorcinol complex with 1,2-cyclohexanediamine-N,N,N′,N′-tetraacetic acid. Iodide concentrations as low as 10^{-8} M can be determined. Chloride and bromide do not interfere at least up to 5×10^{-4} M and 10^{-5} M, respectively. Cationic interferences can be removed by preliminary ion exchange. (auth)

19972 ANION-EXCHANGE SEPARATION AND SPECTROGRAPHIC DETERMINATION OF RARE EARTHS IN PLUTONIUM WITH LITHIUM FLUORIDE–SILVER CHLORIDE CARRIER. Joshi, B. D.; Patel, B. M.; Page, A. G. (Bhabha Atomic Research Centre, Trombay, India). Anal. Chim. Acta; 57: No. 2, 379-86(Dec 1971).

An emission spectrographic method for the determination of traces of rare earths in plutonium with a LiF–AgCl carrier is described. The rare earths are separated from plutonium by anion exchange, concentrated, and estimated. Thulium is used as an internal standard. The lowest detectable amounts are Yb 0.001 μg; Eu, Gd 0.01 μg; Er, Lu 0.025 μg; Nd, Sm, Dy, Ho 0.05 μg; Ce, Pr, Tb 0.1 μg. The effect of microgram amounts of plutonium and thirteen common impurities on detection limits and determination is described. The coefficient of variation ranges from 6 to 12% for different elements. (auth)

19973 SPECTROGRAPHIC MICRODETERMINATION OF REFRACTORY ELEMENTS IN URANIUM. DIRECT SPARK EXCITATION OF A BPHA–CHLOROFORM EXTRACT WITH A SOLUTION TRANSPORT SYSTEM. Muzik, Robert J.; Vita, Orlando A. (Goodyear Atomic Corp., Piketon, Ohio). Anal. Chim. Acta; 57: No. 2, 331-40(Dec 1971).

A procedure for the microdetermination of Mo, Nb, Ta, Tl, W, and Zr in uranium is described. These metals are extracted from uranium in 10 M hydrochloric acid with BPHA (N,N-phenylbenzohydroxamic acid) in chloroform and the extract is spark-excited directly by means of a solution transport system. Hafnium is added to the sample before extraction and acts as a chemical and spectral internal standard. The solution transport system overcomes the problem of low results obtained in the rotating disk technique because of metal chelate vaporization and insoluble oxide formation in the ignition step. The extract is easier to handle and requires one-third less time for a single analysis than other spectrographic procedures for these metals. The detection limits are better than those obtained with the rotating disk method except for tantalum. These limits range from 0.9 μg Ta per g U to 0.1 μg Mo per g U. The standard deviation (average) for all elements in the 2 to 10 μg range obtained with the solution transport system is about 9%, compared to 12.5% with the rotating disk procedure. (auth)

19974 GALLACETOPHENONE OXIME AS A REAGENT FOR GRAVIMETRIC DETERMINATION OF COPPER AND ITS SEPARATION FROM OTHER ELEMENTS. Reddy, K. Adinarayana; Reddy, Y. Krishna (Sri Venkateswara Univ., Tirupati, India). Proc. Indian Acad. Sci., Sect. A; 74: No. 4, 153-8(Oct 1971).

Gallacetophenone oxime is a more useful analytical reagent for the determination of copper in the presence of nickel, cadmium, zinc, manganese, selenium, and iron than either salicylaldioxime or resacetophenone oxime. It is more soluble in water and its gravimetric factor (0.1486) is more favorable than with either salicylaldioxime (0.1895) or resacetophenone oxime (0.1607). The reaction of gallacetophenone oxime with several metal ions (including thorium and uranium) was also studied. (auth)

19975 QUANTITATIVE X-RAY DIFFRACTION ANALYSIS BY A DIFFRACTION: FLUORESCENCE TECHNIQUE. Toussaint, C. J. (EURATOM–CCR., Ispra, Italy). Anal. Chim. Acta; 57: No. 2, 289-93(Dec 1971).

Quantitative x-ray diffraction analysis by means of the basic relationship relating the intensity of the diffracted x-rays to the absorption properties of the sample is described. The mass absorption coefficient is determined from the Mo Kα Compton diffused radiation on an x-ray fluorescence spectrometer. The average relative error for the mass absorption coefficient determination was found to be about 5%. Analyses of synthetic mixtures (NaCl–CuCl and Fe_2O_3-Fe-C) gave a relative error of 1 to 8%, depending on the concentration. The Fe_2O_3-Fe-C system is of practical interest in determining iron oxides in deposits of corrosion products from water-cooled nuclear reactors. (auth)

19976 1-(o-CARBOXYPHENYL)-3-HYDROXY-3-METHYLTRIAZENE FOR THE DIRECT GRAVIMETRIC DETERMINATION OF TITANIUM(IV) IN PRESENCE OF NIOBIUM AND TANTALUM. Majumdar, A. K.; Bhattacharyya, B. C.; Roy, B. C. (Jadavpur Univ., Calcutta). Anal. Chim. Acta; 57: No. 2, 425-8(Dec 1971).

An improved direct gravimetric method for the determination of titanium in the presence of niobium and tantalum, as well as other cations and anions, with a new reagent, 1-(o-carboxyphenyl)-3-hydroxy-3-methyltriazene, is suggested. The titanium (1 to 40 mg) is quantitatively precipitated in the pH range 1.0 to 4.5 and can be weighed as $TiO(C_8H_8O_3N_3)_2$ after drying at 120°. The few serious interferences can be avoided by the use of masking agents. (auth)

19977 DETERMINATION OF U BY COLORIMETRY USING ACENAPHTHENEQUINONEMONOXIME. Sindhwani, S. K.; Singh, R. P. (Univ. of Delhi). Chim. Anal. (Paris); 53: No. 11, 701-3(Nov 1971). (In French).

Acenaphthenequinone monoxime reacts with U(VI) to form yellow-colored precipitates that may be extracted with chloroform. Spectrophotometry was used to determine the composition and other physical constants of the complex. Two components metal: ligand are present in the complex in the ratio of 1 : 2. The complex obeys Beer's law in the 0 to 19.11 ppM U range. The optimum range for the determination is 3.58 to 14.0 ppM. Its sensitivity was found to be 0.0215 μg U/cm² for $\log I_0/I = 0.001$ at pH 5.80. The effect of various ions was also studied. (France)

19978 SEMIQUANTITATIVE DETERMINATION OF THIRTY CATIONS BY CIRCULAR THIN-LAYER CHROMATOGRAPHY. Hashmi, Manzur-ul-Haque; Chughtai, Farhat Rafique (Pakistan Council of Scientific and Industrial Research Labs., Lahore). Mikrochim. Acta; No. 6, 924-37(1971).

A comprehensive scheme for the semiquantitative determination of 30 metal ions (Ag^+, Pb^{2+}, W^{6+}, Tl^+, Fe^{3+}, Au^{3+}, Mo^{6+}, Ga^{3+}, Sb^{5+}, Ge^{4+}, Te^{4+}, Pt^{4+}, Pd^{2+}, Ru^{3+}, Rh^{3+}, Cu^{2+}, Co^{2+}, Ni^{2+}, Zn^{2+}, Cd^{2+}, Cr^{6+}, Mn^{2+}, U^{6+}, V^{5+}, Sn^{4+}, Bi^{3+}, Hg^{2+}, Ti^{4+}, Se^{4+}, and As^{3+}) is described. It is based on a circular thin-layer chromatographic technique. The error is ±5% and 16 other metal ions, not included in

the analysis scheme because of the non-availability of spray reagents, do not interfere. The determination of each cation has been made with different spray reagents separately and the "mean" error has been calculated. The analysis of the same cation with different spray reagents provides a useful check on the results. The method holds an excellent promise for the study of airborne particulates and for the determination of trace elements from blood, tissue, and bone. (auth)

19979 USE OF pH-METER FOR INDICATING THE END POINT OF PRECIPITIMETRY. II. TITRATION OF HALIDES, IODATE, CHROMATE, AND SECONDARY PHOSPHATE. Hotta, Noboru (Toyama Technical Coll., Japan). Jap. Anal.; 20: No. 12, 1522-9(Dec 1971). (In Japanese).

When the precipitimetry of halides, iodate, chromate, and secondary phosphate was carried out in the presence of acetone in aqueous solution, a steep change of apparent pH on the scale reading of the ordinary pH-meter was found to appear near the equivalence point of the titration. Many titration curves were drawn under various conditions to find a suitable procedure for this purpose. The recommended conditions, for example, in the argentometry were as follows: the optimum amount of acetone in 50 ml total volume for obtaining a sharp end point should be 80 to 95% for KCl, 70 to 90 for KBr, 50 to 90 for KI and KIO_3, 20 to 70 for K_2CrO_4, and 30 to 60 for Na_2HPO_4; the minimum detectable concentration by this method was 2×10^{-3}M for all cases. The titration of a mixture of chromate and sulfate with the standard silver nitrate solution could be achieved by the addition of very dilute sodium hydroxide solution into the solution to be tested to elevate its pH to about 7 prior to the titration. The apparent pH-response of an ordinary glass electrode attached to the commercial pH meter was examined for silver, chromate, and secondary phosphate ions in the presence of acetone, and the electrode was able to indicate the end point. This apparent pH-response was remarkable especially for lead ion, and, therefore, a mixed solution of silver nitrate and lead nitrate (10:1) or that of barium nitrate and lead nitrate (10:1) was found more effective to obtain a steep change at the end point. Other polar organic solvents such as ethanol, methanol, and dioxane, all neutral and water soluble, could be used for this purpose. The quantitative graphimetric end point determination by using a commercial pH-meter seems to be more convenient than the potentiometric indication by a silver metal electrode from its acceptable reproducibility for the end point detection. (auth)

19980 POLAROGRAPHIC DETERMINATION OF NIOBIUM IN THE PRESENCE OF TANTALUM. Sobkowska, Aleksandra (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw); 16: No. 5, 1027-33(1971). (In Polish).

Polarographic measurements of Nb(V) reduction in the presence of Ta(V) were carried out. 12 M HCl, 10 M HCl + 20% ethylene glycol, or 0.1 M EDTA solutions were used as supporting electrolytes. The best results were obtained in the solution of 10 M HCl + 20% ethylene glycol, but the determination of Nb in both other supporting electrolytes is also possible. In EDTA solutions the concentration of Nb should not exceed 0.1 mg Nb_2O_5/cm^3. In 12 M HCl or 10 M HCl + 20% ethylene glycol solutions the best concentration of Nb for analysis is within the range of 0.005 to 0.5 mg Nb_2O_5/cm^3. The best shape of polarographic curve is obtained at concentrations close to 0.05 mg Nb_2O_5/cm^3. The analytical procedure is given in which attention is paid to the time period between preparation of solution and recording the polarogram. Reproducible results may be obtained when the recording is done the next day. (auth)

19981 EPSILON-PICRAMINE, NEW REAGENT FOR THE PHOTOMETRIC DETERMINATION OF NIOBIUM. Dedkov, Yu. M.; Dymova, M. S.; Yakovlev, P. Ya. (Inst. of Geochemistry and Analytical Chemistry, Moscow. Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 7, 963-65(Jul 1971).

Translated from Zavod. Lab.; 37: No. 7, 753-6(Jul 1971).

Niobium can be determined photometrically as the 1:1 complex with epsilon-picramine (8-hydroxy-7-[(2-hydroxy-3,5-dinitrophenyl)azo]-1,6-naphthalenedisulfonic acid). The complex is formed in an aqueous solution with a concentration of 0.25 to 4N HCl, and the optical density reaches a maximum value on heating in a water bath for 5 min. The color is stable for 24 hr, and the optical density is measured at 564 nm. With the proper choice of masking agents, the method is applicable to the determination of 0.2 to 4% Nb in the presence of significant excesses of Mo, Zr, Ti, and Ta. The relative error of the method is ±3%. (B.L.M.)

19982 SIMULTANEOUS ASSAY OF NIOBIUM AND TANTALUM IN TECHNOLOGICAL SOLUTIONS BY MEANS OF ^{95}Nb AND ^{182}Ta. Anosov, V. V.; Gavrilov, N. I.; Sobinyakova, N. M.; Smelkova, T. P. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 3, 380-2(Mar 1971).

Translated from Zavod. Lab.; 37: No. 3, 297-9(Mar 1971).

Niobium and tantalum were determined simultaneously by measurement of the γ spectra of ^{95}Nb and ^{182}Ta. The γ rays were filtered, and the ^{95}Nb was determined at the 0.76-MeV photopeak where there are no appreciable peaks for ^{182}Ta. The ^{182}Ta was determined at 1.12 to 1.23 MeV where there are 4 lines. The elements were determined in ratios from 1:1 to 1:100, and the relative standard deviation was ±12%. (B.L.M.)

19983 USE OF LUMINESCENCE OF CRYSTAL PHOSPHORUS BASED ON VANADATES TO DETERMINE IMPURITIES OF THE LANTHANIDES IN OXIDES OF LUTETIUM AND PRASEODYMIUM. Poluektov, N. S.; Smirdova, N. I.; Efryushina, N. P.; Gaba, S. A.; Gorshkova, S. M. (Inst. of General and Inorganic Chemistry, Odessa). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 3, 338-41(Mar 1971).

Translated from Zavod. Lab.; 37: No. 3, 266-9(Mar 1971).

The luminescence of phosphors of the orthovanadates $LuVO_4$ and $Pr_yY_{y-1}VO_4$ activated by lanthanide ions was used for the determination of lanthanide impurities in oxides of Lu and Pr. Preparation of the phosphors is described in detail. The luminescence is activated with uv light. The standard deviation for determination of impurities in Lu_2O_3 and Pr_6O_{11} was ~2%. (B.L.M.)

19984 ANALYTICAL DETERMINATION OF URANIUM IN HIGH-ALLOY STEELS. Peisteiner, E. Radex Rundsch.; No. 2, 442-6(Apr 1971). (In German).

A method for the wet chemical analysis of U-bearing ores has been modified for use on high-alloy steels. The sample is dissolved in HNO_3, and the U is extracted with tributyl phosphate and methylisobutyl ketone, then re-extracted from the organic phase with an aqueous solution of ammonium acetate and ammonium fluoride. Finally, 8-hydroxyquinoline–chloroform solution is added to produce a yellow complex and the U content is determined spectrophotometrically at 470 nm. The results obtained were used to calibrate a vacuum x-ray fluorescence spectrometer. In the range 0 to 0.20% U, the counting rate is proportional to the U content of the steel samples. (Metals Abstr.)

19985 DETERMINATION OF URANIUM BY ULTRAVIOLET ABSORPTION. Jean, M. (CEN de Saclay, Gif-sur-Yvette, France). Anal. Chim. Acta; 57: No. 2, 440-1(Dec 1971). (In French).

A method is given for the determination of uranium in zirconium alloys. The sample is dissolved in a mixture of perchloric, nitric, and sulfuric acids, and then treated with sodium carbonate. It is possible to determine up to 0.5 mg of uranium in the presence of 0.1 g zirconium. Zirconium carbonate is soluble in an excess of alkaline carbonate at pH ~9 by the formation of a complex, probably $[Zr(CO_3)_4]$, which has an appreciable absorption at 200 nm that cancels itself rapidly at about 235 nm, thus permitting the determination of uranium. (E.J.H.)

19986 METHOD OF BURNUP ESTIMATION FROM MASS SPECTROMETRIC DATA. Kawai, Toshio; Kiguchi, Takashi; Senoo, Makoto (Atomic Energy Research Lab., Hitachi, Japan). Nippon Genshiryoku Gakkaishi; 14: No. 1, 10-14(Jan 1972). (In Japanese).

Exposure of a natural uranium sample irradiated in a thermal reactor is estimated from isotopic ratios of U and Pu measured by a mass spectrometer. The analysis was performed with a set of point burnup equations with effective cross sections as functions of the neutron temperature. Through the isotopic ratio-exposure relations obtained by the analysis, five isotopic ratios yield five exposure data with different accuracies. The error caused by the analytical method results in systematic deviations on the exposure data, which can be separated from the random deviations incurred in the measurements. By means of the theory of errors the exposure is estimated to be 7,530 ± 380 MWD/TU from these data, which indicates that the simple analytical model gives fair results in the present case. The error in the exposure is found to consist of two terms; one of which reduces to zero as the accuracy of the measurement improves, and is defined as the measurement error. The other term, the modeling error, originates from the error in the analytical model. The modeling error predominates when accurate measurements indicate significant discrepancies between the estimated exposures from different abundance ratios. The modeling error can be used as a measure to know whether further improvement in the analysis is necessary. (auth)

19987 ENHANCEMENT OF STRONTIUM ABSORPTION IN THE NITROUS OXIDE–ACETYLENE FLAME BY POTASSIUM AND SODIUM AND THE DETERMINATION OF STRONTIUM IN BIOLOGICAL MATERIAL. van Puymbroeck, Sylvain; van der Borght, Oscar (SCK–CEN., Mol, Belgium). Anal. Chim. Acta; 57: No. 2, 441-6(Dec 1971).

Results of a study of the atomic absorption determination of

strontium in biological materials with the nitrous oxide–acetylene flame show that it is necessary that a careful check be made for sufficient potassium and sodium in both sample and standard. (D.H.M.)

19988 DETERMINATION OF ZIRCONIUM IN STEELS. Ratcliffe, D. B.; Byford, C. S. (Marchwood Engineering Labs., Southampton, Eng.). Anal. Chim. Acta; 58: No. 1, 223-7(Jan 1972).

A method is described for the determination of zirconium in steels. It has been successfully applied to the analysis of welding electrodes, and weld metals. The only elements out of 40 tested found to interfere in the given procedure are gold, thorium, uranium, and hafnium. Hafnium reacts in an identical manner to zirconium and is equally sensitive on a molar basis, i.e., the apparent zirconium content of a steel will be increased by 0.51% by every 1% of hafnium present. However, the hafnium–zirconium ratio in most compounds and alloys (other than specially purified zirconium alloys) is about 1 : 99 and will therefore not significantly affect the result. The other metals are extremely unlikely to be present in weld metals in large amounts and the method can be considered to be virtually specific for zirconium in these circumstances. The precision of the method is such that eleven consecutive analyses of total zirconium in steel gave a mean value of 0.095% Zr (N.B.S. SRM No. 467, certified value 0.094% Zr) with a standard deviation about the mean of 0.0016%. Twelve steels can be analyzed for acid-soluble zirconium in 3 h or for total zirconium content in 6 h. (auth)

19989 INTEGRATOR FOR LOW ABSORBANCE SAMPLES IN ATOMIC ABSORPTION SPECTROSCOPY. Nishita, H.; Farmer, R.; Peterson, S. (Univ. of California, Los Angeles). Anal. Chim. Acta; 58: No. 1, 1-6(Jan 1972).

An analog integrator for samples giving low absorbance in atomic absorption spectroscopy is described. Its performance is demonstrated by the use of aqueous solutions of cesium (0.5 $\mu g\ ml^{-1}$). (auth)

19990 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM(VI) WITH 3-THIANAPHTHENOYLTRIFLUOROACETONE. Johnston, J. R.; Holland, W. J.; Gerard, J. (Univ. of Windsor, Ont.). Mikrochim. Acta; No. 6, 886-91(1971).

Two visible spectrophotometric methods are described for the determination of uranium(VI) with 3-thianaphthenoyltrifluoroacetone at a pH of 6.0. The effect due to pH, time, solvents, reagent concentration, and diverse ions are reported. Beer's law is obeyed in both cases and the molar extinction coefficients at 408 and 446 nm are 1.7×10^4 and 2.3×10^3, respectively. (auth)

19991 DETERMINATION OF NOBLE AND BASE METALS IN OSMIRIDIUM, NATIVE PLATINUM, AND SPERRYLITE BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Sen Gupta, J. G. (Geological Survey of Canada, Ottawa). Anal. Chim. Acta; 58: No. 1, 23-37(Jan 1972).

Atomic absorption spectrophotometric methods for determining the noble and base metals in osmiridium, native platinum, and sperrylite were developed and applied to the analysis of some naturally occurring samples. The sample is decomposed by dry chlorination at 700° in the presence of sodium chloride, or by treatment with aqua regia (native platinum) or Br_2–KBr (sperrylite) followed by dry chlorination of the insoluble residue. Osmium and ruthenium are separated by distillation with perchloric acid and collected in hydrobromic acid. From different aliquots the noble metals are determined in the presence of 0.5% Cu–0.5% Cd buffer and the base metals in the presence of 1% lanthanum or strontium buffer. (auth)

19992 MICROCOULOMETRIC ARGENTIMETRIC TITRATIONS. Ladenson, Jack H.; Purdy, William C. (Univ. of Maryland, College Park). Anal. Chim. Acta; 57: No. 2, 465-8(Dec 1971).

A microcoulometric titration method using electrogenerated silver(I) is described that is applicable to any titration with silver(I) including titration of iodide, and is suitable for titrating substances that require an excess of titrant, e.g., thiourea and protein sulfhydryl groups. With an excess of silver(I) present, the indicator current remained constant for at least 15 min. This stability allows the use of a direct proportion in calculating the results and makes the detection of the end point easier. (D.H.M.)

19993 MICROVOLUMETRIC DETERMINATION OF SCANDIUM BY TITRATION WITH TIRON. Tischenko, M. A.; Alakaeva, L. A.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 496-7(Apr 1971).

Translated from Zavod. Lab.; 37: No. 4, 394-5(Apr 1971).

The suitability of Tiron for the titrimetric determination of Sc at pH 5 to 7 was studied and vindicated. The indicator employed was eriochromocyanine R. Rare earth ions in no way interfered with the determination at pH 5, nor did Li, K, Na, Ca, Mg, Ba, Sr, B, Cd, Mo, W, or Ge at pH 5 or 7. A typical accuracy was 0.2%. (Metals Abstr.)

19994 SPECTROPHOTOMETRIC INVESTIGATION OF A NEW REAGENT ARSENAZO–KhIMDU. Basargin, N. N.; Akhmedli, M. K.; Islamov, Sh. U. (Azerbaidzhan State Univ., Baku). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 3, 342-4(Mar 1971).

Translated from Zavod. Lab.; 37: No. 3, 269-71(Mar 1971).

An arsenazo analog, arsenazo–KhIMDu, (sodium 2-[(N,N-bis(carboxymethyl)aminomethyl]-1,8-dihydroxynaphthalene-3,6-disulfonate) was used for the photometric determination of rare earths of the Y subgroup. The rare earths form 1 : 1 complexes with the reagent, and have an absorption maximum at 580mμ. The instability constant for the Y complex is 1.84×10^{-7}. The complexes are fairly independent of pH over the range of 5 to 9. The sensitivity of this reagent is about 1.5 times lower than that of arsenazo, but it suffers from fewer interferences. The reactions of the reagent with other cations that might interfere are discussed. Beer's law applies over the concentration range of rare earths from 0.4 to 4.0 mg/ml. (B.L.M.)

19995 GRAVIMETRIC DETERMINATION OF NIOBIUM BY ITS ARSENATE. Mukhin, O. S.; Mamedov, I. A.; Suleimanova, E. I. (Azerbaydzhan Inst. of Petroleum and Chemistry, Baku). Azerb. Khim. Zh.; No. 1, 129-32(1971). (In Russian).

The optimum conditions were determined for the separation of Nb arsenate from 5 to 8N HNO_3 solutions, and a quantitative determination of Nb may be made from 5% HNO_3 by adding Na arsenate in the presence of tartrate ion. The ionic forms of the following metals do not interfere: Na, K, Ca, Fe, Mg, Cr, Mn, Zn, Co, Ni, Cd, Ca, and the ions MoO_4^{2-} and $Cr_2O_7^{2-}$. The ions Th^{4+}, Ti^{4+}, Hf^{4+}, and WO_4^{2-} cause some interference. (K.S.W.)

19996 CHELATOMETRIC TITRATION FOR MAGNESIUM AND CALCIUM BY 1-DICARBOXYMETHYL-AMINOMETHYL-2-HYDROXY-3-NAPHTHOIC ACID AS A FLUOROCHROMIC INDICATOR. Nagasaki, Chieko; Toei, Kyoji (Okayama Univ., Tsushima, Japan). Jap. Anal.; 21: No. 1, 87-91(Jan 1972). (In Japanese).

1-Di(carboxymethyl)aminomethyl-2-hydroxy-3-naphthoic acid (DHNA) was prepared by refluxing 2-hydroxy-3-naphthoic acid, iminodiacetic acid, and formalin in sodium hydroxide solution at 60 ~ 70°C for seven hours. DHNA reacts with some metal ions to emit fluorescence under ultraviolet rays (366 nm). The absorption and fluorescence spectra of DHNA, DHNA-Ca and DHNA-Mg are measured at pH 11 and 12. The centers of the fluorescence spectra are 500 nm (pH 11), 490 nm (pH 12) for DHNA; 485 nm (pH 11, 12) for DHNA-Ca, and 455 nm (pH 11), 465 nm and 510 nm (pH 12) for DHNA-Mg, respectively. The limits of identification (μg/ml) under ultraviolet rays were Mg (0.1>), Ca (0.5), Cd (0.4), Zn (0.4), Sr (4), Al (0.1>) and Th (2) respectively. From these results, DHNA is implied to be an excellent fluorimetric reagent for magnesium and aluminum. (auth)

19997 SPECTROPHOTOMETRIC DETERMINATION OF BISMUTH(III) AND THORIUM(VI) WITH METHYLXYLENOL BLUE. Enoki, Takehisa; Mori, Itsuo; Yamazaki, Misako; Inoue, Michiko (Osaka Coll. of Pharmacy). Jap. Anal.; 21: No. 1 31-6(Jan 1972). (In Japanese).

Methylxylenol Blue (MXB) reacted with bismuth and thorium to form water-soluble complexes. MXB formed a blue complex with thorium in the presence of excess cetylpyridinium chloride (CPC) in an acidic solution, and its color was very stable. These colors were applied for spectrophotometric determinations of bismuth and thorium. The absorbances of the complexes were constant over the pH range from 1.0 to 1.4 (MXB-Bi), and 1.45 to 1.6 (MXB-Th) by adjustment with nitric acid. Linear calibration curves were obtained for 0 to 20.0 μg/ml of bismuth, and 0 to 23.2 μg/ml of thorium. (auth)

19998 DETERMINATION OF TRACE AMOUNTS OF NICKEL IN RARE EARTH OXIDES BY USING ANODIC STRIPPING VOLTAMMETRY. Hagiwara, Kazuyoshi; Shinohara, Tetsuya (Government Industrial Research Inst., Osaka). Jap. Anal.; 21: No. 1, 62-8(Jan 1972). (In Japanese).

The anodic stripping method was studied for the determination of trace amounts of nickel in rare earth oxides. Potassium thiocyanate was found to be the most suitable supporting electrolyte for this purpose. Nickel is electrodeposited at −1.0 V (vs. SCE) for 15 min or 1 hr on a platinum wire electrode. An anodic dissolution curve is then recorded by linearly varying potential over a range of −1.0 to 1.0 V (vs. SCE) at a rate of 2.4 V/min. The platinum wire electrode is polished previously with aluminum

oxide powder (about 200 mesh) and with a small piece of filter paper on which a small amount of sodium bicarbonate is put. It is then treated at +0.4 V (vs. SCE) for about 5 min in the supporting electrolyte solution after washing with nitric acid and water. The electrode could be used many times over. (auth)

19999 SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN METALLIC ZIRCONIUM. Kleinmann, Imrich; Vockova, Jana (Inst. for Research, Production, and Use of Radioisotopes, Prague). Jad. Energ.; 17: No. 11, 374-9(Nov 1971). (In Czech).

A method for simultaneous determination of B, Cd, Dy, Eu, Gd, Sm, Hf, Ag, Co, Mn, Fe, and Ni is described. The choice of inner standard and buffer was thoroughly studied. An optimal compromise for spectrographic buffer seems to be a mixture of graphite and sodium fluoride (10:1), admixed to the sample in a 1:2 ratio. For all these impurities (with the exception of Cd) a line of inner standard could be found decreasing the standard deviation 2 to 3 times. (auth)

20000 DETERMINATION OF CADMIUM, COBALT, CHROMIUM, MAGNESIUM, MANGANESE, AND NICKEL IN URANIUM COMPOUNDS BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Jaros, Jaroslav (Czechoslovak Uranium Industry, Mydlovary). Jad. Energ.; 17: No. 9, 307-11(Sep 1971). (In Czech)

A method for the determination of Cd, Co, Cr, Mg, Mn, and Ni in nuclear pure uranium and its compounds by atomic absorption spectrophotometry is described. After the separation of uranium by extraction using tributyl phosphate, the individual elements are determined in an aqueous phase. This procedure permits concentrations down to 0.01 μg/g Mg, 0.02 μg/g Cd, 0.06 μg/g Cr, 0.06 μg/g Mn, 0.13 μg/g Co, and 0.17 μg/g Ni to be determined. The coefficients of variation of the elements determined are in the range 2.2 to 4.5%. Results are in good accordance with results obtained by spectrographic and spectrophotometric analyses. The behavior of the elements determined and the interferences of Al, Fe, P, Si, and U were checked. (auth)

20001 ATOMIC ABSORPTION AND ATOMIC FLUORESCENCE SPECTROSCOPY OF BIOLOGICAL MATERIAL. Bek, Frantisek; Sychra, Vaclav (Vysoka Skola Chemicko-Technolgicka, Prague). Chem. Listy; 65: No. 12, 1233-55(Dec 1971). (In Czech).

The advantages of the utilization of atomic absorption and atomic fluorescence spectroscopy for determination of trace amounts of elements such as Sr, I, Te, Mo, Nb, U, and W in biological materials are reviewed. (M.C.G.)

20002 SPECTRAL DETERMINATION OF IMPURITIES IN BORIC ACID. Tarasevich, N. I.; Zheleznova, A. A.; Abdullaev, A. A. Vestn. Mosk. Univ., Ser. II, Khim.; 12: No. 5, 593-6 (Sep-Oct 1971). (In Russian).

A spectral method was suggested for the quantitative determination of impurities (Mo, Cu, Al, Mn, Co, Cd, and Ni) in aqueous solutions of boric acid with the use of ultrasound dispersion of a sample into spark discharge. (auth)

20003 DETERMINATION OF TOTAL IODINE AND IODATE IN SEA WATER AND IN VARIOUS EVAPORITES. Schnepfe, Marian M. (Geological Survey, Washington, D. C.). Anal. Chim. Acta; 58: No. 1, 83-9(Jan 1972).

Iodine in seawater and evaporites is determined spectrophotometrically as the starch–iodine complex without prior separation or concentration of the iodine. In slightly alkaline solution, iodide is first oxidized to iodate with permanganate. Oxidized states of manganese are destroyed with iron(II) in phosphate medium without affecting the iodate. After acidification, iodide is added to react with the iodate in the presence of starch. The iodate content is determined by the same procedure, but without the addition of permanganate. As little as 0.1 μg of iodine is determinable in the presence of 500 mg of chloride and 5 mg of bromide. The total iodine concentration in seven samples of seawater was found to vary from 50 ± 3 to 84 ± 6 μg l^{-1} with 50 to 100% present as the iodate. (auth)

20004 CESIUM-SENSITIVE ELECTRODE. Coetzee, C. J.; Basson, A. J. (Univ. of the Western Cape, Bellville, South Africa). Anal. Chim. Acta; 57: No. 2, 478-80(Dec 1971).

An electrode sensitive to cesium ion was constructed employing a cesium 12-molybdophosphate precipitate in an inert support, enabling cesium activities to be measured directly. An investigation was made of the effect of pH on electrode potential, effect of temperature on electrode response, dynamic response characteristics, and effect of cations on electrode response. (D.H.M.)

20005 DETERMINATION OF URANIUM IN EXPLORATION SAMPLES BY X-RAY EMISSION SPECTROMETRY. Clark, N. H.; Pyke, J. G. Anal. Chim. Acta; 58: No. 1, 234-7(Jan 1972).

A ratio technique is described that offers analysts a rapid and accurate method for the evaluation of a uranium exploration prospect. Determination of U_3O_8 between 0.010% and 1.923% (0.2 to 38.4 lb/short ton) can be effected with an expected relative reproducibility of ±4%. Samples are presented as loose powder (200 mesh). Full calibration takes 2 man-shifts, and each sample has an analysis time of not greater than 7 min. (auth)

20006 ANALYTICAL STANDARDS FOR ACCOUNTABILITY OF URANIUM HEXAFLUORIDE. New York; American National Standards Institute [(1970)]. 53p.

An analytical standard for the accountability of uranium hexafluoride is presented that includes procedures for subsampling, determination of uranium, determination of metallic impurities, and isotopic analysis by gas and thermal ionization mass spectrometry. (auth)

20007 SPARK-SOURCE MASS SPECTROMETRIC TECHNIQUES FOR THE ANALYSIS OF LANTHANIDE AND ACTINIDE ELEMENTS IN MICROGRAM AND SUB-MICROGRAM TRANSURANIUM SAMPLES. Carter, Joel A. (Oak Ridge National Lab., Tenn.); Cameron, A. E.; Dean, John A. Anal. Lett.; 4: No. 6, 337-50(Jun 1971).

Lanthanide and actinide impurities in a total sample of 1 to 10 μg of transuranic matrix can be determined by employing the spark-source mass spectrograph and solution technique. A special source glove box permits safe manipulation of transuranium elements with α-emitting radioactivity up to 10^{12} dpm. The minimum detection limit is about 10^{12} atoms per electrode system, and an exposure of 10^{-8} Coulomb. Relative sensitivity values for the lanthanides and actinides were established with respect to erbium, the internal standard. (auth)

20008 SPECTROPHOTOMETRIC STUDY OF URANIUM(VI) COMPLEX WITH 1-(2-PYRIDYLAZO)-2-PHENANTHROL (PAP). Rishi, A. K.; Garg, B. S.; Singh, R. P. (Delhi Univ.). Curr. Sci. (India); 41: No. 4, 155-6(20 Feb 1972).

The pinkish-red water-insoluble complex formed as a result of the reaction of U(VI) with 1-(2-pyridylazo)-2-phenanthrol (PAP) is soluble in 70% methanol and shows maximum absorbance at 550 nm. The absorbance of the complex, measured at 550 nm, remains constant in the pH range 6.5 to 8.5. The optimum concentration range for the determination of uranium, as found from the Ringbom plot is 1.6 to 7.5 ppM, and the sensitivity of the reaction is 0.0082 μg U(VI) cm^{-2} for 0.001 absorbance. The interference of foreign ions was evaluated. (J.G.B.)

20009 EXTRACTION–SPECTROGRAPHIC AND PHOTOMETRIC METHODS OF ANALYSIS OF PLATINUM METALS. II. EXTRACTION–SPECTROGRAPHIC DETERMINATION OF MICROIMPURITIES OF Ir, Rh, Ru, AND Pd IN HYDROCHLORIC ACID SOLUTIONS OF PLATINUM. Vasil'eva, A. A.; Shelpakova, I. R.; Gindin, L. M.; (and others) (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 4, Ser. Khim. Nauk; No. 2, 81-5(Mar 1971). (In Russian).

An extraction and spectrographic method for determination of microimpurities of Ir, Rh, Ru, and Pd in HCl solutions of platinum is suggested. The method is based on removal of platinum by extraction with a solution of tetraoctylammonium bromide. The concentrate of microimpurities on a carbon collector was analyzed spectrographically. Sensitivity of the analysis is discussed. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 20334, 20365, 20366, 20373, 20550, and 22103.

20010 (NBL–262, pp 65-7) TENTATIVE GAMMA-RAY SPECTROMETRIC METHOD FOR THE DETERMINATION OF ^{226}Ra IN SOIL SAMPLES. Nelson, L. C. Jr. (New Brunswick Lab. (AEC), N. J.).

A tentative direct procedure for determining ^{226}Ra in soil was developed. It involves measurement of the 186-keV gamma peak. Calculations were performed by means of a FOCAL computer program. (auth)

20011 (NBL–262, pp 68-71) FOCAL COMPUTER PROGRAM TO CALCULATE SOIL AND WATER RADIOACTIVITIES. Nelson, L. C. Jr. (New Brunswick Lab. (AEC), N. J.).

The determination of total alpha and beta activities plus the activities of ^{226}Ra and ^{228}Ra in soil and water samples involves corrections for background, efficiency, and sample size, and, for soil samples, correction for moisture. These calculations are performed by means of a FOCAL computer program. (auth)

20012 (NBL–262, pp 72-4) FOCAL COMPUTER PROGRAM FOR THE CALCULATION OF $^{238}Pu/^{239}Pu$ RATIOS DETERMINED

BY ALPHA SPECTROMETRY. Zyskowski, C. (New Brunswick Lab. (AEC), N. J.).

A short computer program in the FOCAL language was written to perform the necessary calculations in the determination of ^{238}Pu by α spectrometry. The tabular form of entry and response is used. (auth)

20013 (ORNL-tr-2557) USE OF ISOTOPIC NEUTRON SOURCES IN RESONANCE-SPECTRUM ANALYSIS FOR ELEMENTS. Kazachenkov, Yu. N.; Shtan, A. S. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Radiats. Tekh.; No. 6, 126-31(1971). 8p. Dep. NTIS.

A quantitative evaluation was made of the precision of a method of analysis using isotopic pulsed neutron sources. Interactions of the neutrons with nuclei of the absorber at resonance and emission of prompt gammas are discussed. (M.C.G.)

20014 DETERMINATION OF THE BETA-RADIOACTIVITY IN WATER. NEN 2395 1962. 's Gravenhage, Netherlands; Nederlands Normalisatie-Instituut (1962). 4p. (In Dutch).

The step-by-step procedure for the determination of the β activity of water is given. The sample was evaporated to dryness after addition of ammonium carbonate. From a known fraction of the residue the radioactivity was determined with a Geiger counter. (J.S.R.)

20015 DETERMINATION OF ^{137}Cs IN THE SOIL WITH A Ge(Li) DETECTOR. Toeroek, Istvan. Agrokem. Talajtan; 20: No. 1-2, 203-4(1971). (In Hungarian).

Cesium is an important contaminant that may reach the soil from the fallout with the rainwater. Because of its low concentration, special techniques must be used to determine it. A novel method has been developed at the Casaccia (Italy) Nuclear Center, using a Ge(Li) semiconductor detector spectrometer. The crystal is kept at liquid nitrogen temperature; the system also contains an amplifier, a 4096-channel analyzer, a PDP computer, and a Packard monitor. The crystal used had a resolution of 3.5 keV and was operated with a 20-cm Pb shield. The spectra of soil specimens taken with a NaI crystal exhibited a single peak; use of the Ge(Li) allowed to separate and individually evaluate the peaks. This allowed measurement of the ^{137}Cs activity with an accuracy of ±6% in specimens containing more than 1000 pCi. The new technique allows determination simultaneously of the peaks corresponding to ^{144}Ce, decay products of Ra and Th and ^{40}K, in addition to ^{137}Cs. The technique is well suited for the environmental monitoring of radioactivity; the evaluation of the data may be completely automated. (TTT)

20016 UNIDENTIFIED α-ACTIVITY OF THORITE. Petrzhak, K. A.; Yakunin, M. I.; Ter-Akop'yan, G. M. At. Energ. (USSR); 32: No. 2, 179-80(Feb 1972). (In Russian).

Samples of thorite were obtained by grinding a type of granite and classifying the particles in bromoform. A heavy fraction was subjected to α-spectral analysis, and about 15 peaks were readily identified as to radioisotopic source, but a peak at about 4.4 MeV observed but not identified by other workers could not be found. (K.S.W.)

20017 IMPROVING THE ACCURACY OF ANALYSIS BASED ON THE BACK SCATTERING OF β RADIATION. Ivanov, V. I.; Belyus, L. M. (Magnitogorsk Mining Metallurgical Inst., USSR). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 3, 383-5(Mar 1971).

Translated from Zavod. Lab.; 37: No. 3, 300-2(Mar 1971).

In the radiometric determination of iron in ore samples by backscattering difference in the grain size within a sample leads to differences in iron content of as much as 7%. The accuracy is improved if each fraction of the ore is analyzed separately, and the iron content for the whole sample is then calculated taking into account the weight contributions of each fraction. Studies are reported to estimate the advantages of this fractional radiometric analysis. For the range of iron concentrations investigated (from 51 to 65% in oxide ores and from 27 to 60% in sulfide ores) the accuracy of the radiometric analysis was found to be no worse than for chemical analysis. (B.L.M.)

20018 DETERMINATION OF TOTAL RARE EARTH CONCENTRATION FOR SOLUTIONS. Betin, Yu. P.; Kotik, U. I.; Pozina, M. I. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 3, 377-9(Mar 1971).

Translated from Zavod. Lab.; 37: No. 3, 294-7(Mar 1971).

A new apparatus is described for determining total rare earth concentration in industrial stock solutions by a γ-absorption method. These stock solutions contain up to 50g/l free acid as well as $Al(NO_3)_3$ and NH_4NO_3. The apparatus employs two radiation sources differing in energy spectrum. One source radiated via a collimator onto the cell containing the solution and the transmitted radiation passes to a scintillation counter and then to a photomultiplier. The second source serves to correct the readings for density changes, and its radiation falls on a compensating wedge. Then the γ rays pass through a second cell containing the solution and then on the scintillator. The fluxes from the two sources are recorded separately by an electromechanical system. Using a ^{170}Tm source as the first source, the apparatus is applicable to the determination of total concentration of elements with $Z \geq 66$ with less than ±3% error. If all rare earths are present, a ^{147}Pm source gives better precision. (B.L.M.)

20019 CALCULATION OF INTERELEMENT EFFECTS IN X-RAY FLUORESCENCE ANALYSIS. Grothe, K. H.; Rackur, H. (Technische Univ., Hanover). Anal. Chim. Acta; 58: No. 1, 65-73(Jan 1972). (In German).

A method for the calculation of interelement effects in x-ray fluorescence spectroscopy is described. The percentage of the total excitation of the fluorescence of one element which is produced within the sample by fluorescence of another element, can be calculated by simple mathematical techniques. This is done by comparison of experimental results with theoretical calculations for the example of Y–Zr mixtures, in which the $YK\alpha_{1,2}$ line is excited by the Zr β radiation. The contribution of this excitation to the total excitation amounts to 9% for 10% Zr (by weight), 20% for 50% Zr and 40% for 97% Zr in the mixture. (auth)

20020 CONTRIBUTION TO TRITIUM MONITORING OF PERSONS. Haschke, J. (Hygienisches Inst., Hamburg). Arch. Hyg. Bakteriol.; 154: No. 2, 138-42(1971). (In German).

A liquid sample changer with scintillation counter, described in this journal (1969, No. 5, pp. 383-389) is equally suitable for the routine examination of tritium in urine. Depending on the required degree of accuracy, three or four different methods of pretreating the urine are available. Irrespective of the choice of method, the official minimum requirements are met reliably and with good accuracy. (INIS)

20021 DICHROMATIC ATTENUATION TECHNIQUE FOR THE IN VIVO DETERMINATION OF BONE MINERAL CONTENT. Judy, Philip F. Madison, Wis.; Univ. of Wisconsin (1971). 134p. University Microfilms Order No. 71-28,342.

Thesis.

The determination of the composition of a two-component substance by gamma and x-ray attenuation was studied. The particular application investigated was the measurement of human limbs, which were assumed to contain a bone mineral component and a soft tissue component. Radionuclides (^{125}I, ^{241}Am, and ^{153}Gd) were used as sources of nearly monoenergetic photon beams. The attenuation was measured by securely and reproducibly holding the limb or other objects between a collimated NaI(Tl) scintillation detector and a source position. The collimated photon sources were mounted on a wheel, which permitted each source to be sequentially and reproducibly placed in the source position. The formulas used in the dichromatic attenuation technique (DAT) were derived from simple exponential attenuation theory. The difficulties of such attenuation measurements were the deviation of the attenuation of the photon beams from the exponential formulas, the variation of the composition of the human tissues, and the problems of repositioning the body from measurement to measurement. Deviation from exponential attenuation was related to the size of the photon beams, monochromaticity of the photon beams, and the scattered radiation detected. Of these factors the photon beam size had the most effect. The size of the photon beams, and the effects of size, were estimated from experimentally determined beam profiles. The size of the ^{125}I beams (28-keV) ranged from 1.5 to 3 mm in diameter, and the size of the ^{241}Am beams (60-keV) ranged from 2.5 to 4 mm. Using these beams the DAT estimate of the bone mineral component deviated from an accurate value by as much as 30% near the edge of the bone, and a 10% deviation was typical. The scattered radiation was measured by examining the transmission of the photon beams as a function of detector aperture size. The scattered radiation constituted 5% to 15% of the detected photons for the ^{125}I and ^{241}Am beams and for thicknesses of tissue of the limbs, but the exponential characteristic of the attenuation was not altered. Deviation of the beams from monochromaticity was evaluated from the spectrum of the photon beams. The hardening of the ^{125}I beam caused a 3 mg/cm^2 decrease in the estimated bone mineral content (BMC) per g/cm^2 of soft tissue cover. Compensation for this small deviation was possible. The effect of the variation in the composition of soft tissue and bone mineral was investigated. The effects of the repositioning error could be large. (Diss. Abstr. Int., B)

Separation Procedures

Refer also to abstracts 20052 and 21869.

20022 (ANL-Trans-909) STUDY OF RELATIONS BETWEEN THE CHROMATOGRAPHIC BEHAVIOR OF METAL IONS IN EXTRACTION CHROMATOGRAPHY (HDEHP) AND THE IONIC PARAMETERS OF THE SPECIES IN SOLUTION. Poli, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Translated for Argonne National Lab., Ill., from report RT/CHI-(70)32. 24p. Dep. NTIS.

An attempt was made to correlate the behavior of various elements, including rare earths, in an extraction column with the complexing constants of these elements with DEHPA and the energy of the bonds formed between the metal ion and the chelating agent. (M.C.G.)

20023 (NBL-262, pp 41-2) EVALUATION OF THE DIRECT FUSION, LEACH-PLUS-FUSION, AND LEACH-FUSION METHODS FOR THE DISSOLUTION OF PLUTONIUM DIOXIDE-URANIUM DIOXIDE. Wenzel, A. W.; Pietri, C. E. (New Brunswick Lab. (AEC), N. J.).

Insolubles remaining after a HNO_3-HF dissolution of mixed plutonium and uranium oxides can be treated in two ways, both of which involve a sodium bisulfate fusion. Although both are reliable, procedure involving the evaporation of the entire solution after the acid treatment followed by a fusion is somewhat simpler and quicker than the one requiring a filtration and fusion of the separated residue. (auth)

20024 SEPARATIONS OF PARTICLES, MOLECULES, AND IONS BY FOAMING: STUDIES IN JAPAN. Sasaki, T. (Tokyo Metropolitan Univ.). pp 273-8 of Adsorptive Bubble Separation Techniques. /Lemlich, Robert (ed.). New York; Academic Press Inc. (1971).

The separation of particles, molecules, and ions by foaming is reviewed including ion flotation (adsorption flotation, precipitation flotation, and adsorbing particle flotation) and molecule and particle flotations. (D.H.M.)

20025 ACETYLACETONE ADDUCTS OF RARE EARTH TRIS-THENOYLTRIFLUOROACETONATES IN SYNERGISTIC SOLVENT EXTRACTION. Woo, Ching; Wagner, William F.; Sands, Donald E. (Univ. of Kentucky, Lexington). J. Inorg. Nucl. Chem.; 34: No. 1, 307-12(Jan 1972).

The synergistic effect of acetylacetone (Hacac) in the extraction of rare earth thenoyltrifluoroacetonates ($Mtta_3$) was attributed to the formation of the species $Mtta_3 \cdot Hacac$. The adduct was isolated and identified by chemical analyses and ir spectra. (auth)

20026 EXTRACTION OF NITRIC ACID AND Np(IV) BY SOME ALIPHATIC KETONES AND ALCOHOLS. El-Naggar, H. A.; Shehata, M. K.; Abdel-Gawad, A. S. (Atomic Energy Establishment, Cairo). Z. Anorg. Allg. Chem.; 386: No. 1, 113-21(Dec 1971).

The extraction behavior of HNO_3 and Np(IV) from aqueous nitrate solutions with some aliphatic alcohols and ketones using hexane, carbon tetrachloride, benzene, and chloroform as diluents was studied. The acid concentration in the aqueous phase varied from ~0.25 to 10 M and that of the extractant in the organic phase varied from 0.5 M to the undiluted fraction. In the alcohol systems, solutions of the same alcohol in the diluents CCl_4,and $CHCl_3$ showed similar capacity for acid extraction, and also in the same diluents, solutions of diisopropyl and diisobutyl carbinol showed similar capacity for extraction. Extraction of Np(IV) with the different ketones and alcohols used follow the same pattern as HNO_3. (auth)

20027 SELECTIVE EXTRACTION OF MOLYBDENUM(V) THIOCYANATE WITH N-BENZYLANILINE. Khosla, M. M. L. (Defence Lab., Jodhpur, India); Rao, S. P. Anal. Chim. Acta; 57: No. 2, 323-9(Dec 1971).

N-Benzylaniline in chloroform-isoamyl alcohol mixture is shown to be a selective extraction reagent for molybdenum(V) thiocyanate complex in 1.8 M sulfuric acid or 2.8 M hydrochloric acid media. Few cations interfere. Palladium, platinum, rhodium, gold, rhenium, and tellurium which interfere seriously in the conventional extraction thiocyanate method do not interfere. Phosphate, oxalate, citrate, tartrate, borate, arsenate, dichromate, chromate and vanadate do not interfere. Beer's law is obeyed in the range 0 to 50 μg Mo ml^{-1}. The molar absorptivity of the extracted orange-red complex is 16380 ± 90. The method is simple and rapid and effects a clean cut separation. (auth)

20028 CATION EXCHANGE IN FORMIC ACID-DIMETHYL SULPHOXIDE MEDIA: SEPARATION OF THORIUM FROM URANIUM, YTTRIUM, LANTHANUM, AND CERIUM. Qureshi, Mohsin; Husain, Khadim (Aligarh Muslim Univ., India). Anal. Chim. Acta; 57: No. 2, 387-92(Dec 1971).

Cation-exchange studies for 26 metal ions in dimethyl sulfoxide, acetone, and formic acid-DMSO-water systems on Dowex 50W-X8 are reported. Thorium can be separated from uranium, yttrium, lanthanum, and cerium by elution first with DMSO and then with 2M nitric acid. (auth)

20029 SEPARATION PROCESS FOR ACTINIDES. Baudet, Maurice; Koehly, Gerard; de Mora, Francine (to Commissariat a l'Energie Atomique). French Patent 2,068,159. 26 Jul 1971. Filed 28 Nov 1969. (In French).

A process for separating actinides is described. The process consists of adding a complexing agent to an acid solution containing the actinides to be separated and adding a chelating agent, if necessary, to bring the H^+ ion titer to a value between 0.5 and 10^{-2}. The solution is put in contact with an organic phase containing an agent that selectively extracts the trivalent actinide elements. (France)

20030 THERMODYNAMICS OF PLUTONIUM(IV) EXTRACTION FROM PERCHLORIC AND NITRIC ACID SOLUTIONS IN THE PRESENCE OF OXALIC ACID. Solovkin, A. S.; Ivantsov, A. I. At. Energ. (USSR); 32: No. 2, 164-6(Feb 1972). (In Russian).

The extraction of Pu(IV) from aqueous solutions of $HClO_4$ and from aqueous solutions of HNO_3 by a solution of 2-thenoyltrifluoroacetone in benzene was studied. A distribution coefficient (D) was defined in terms of activities, activity coefficients, and thermodynamic equilibrium constants. Experimental and calculated values of D were in fair agreement. Values of D were similarly determined for Pu(IV) as above but with added oxalic acid. Extractions were also made of Pu(IV) from HNO_3-$H_2C_2O_4$ solutions by TBP in decane, and D values were tabulated. (K.S.W.)

20031 EXTRACTION OF NIOBIUM WITH AMINE IN HYDROFLUORIC ACID MEDIUM. Hobin, M. A.; De Sousa, A. S.; Bielecki, E. J. TMS Paper No. A71-56. New York; American Institute of Mining, Metallurgical, and Petroleum Engineers (1971). 13p. $3.00.

Niobium can easily be extracted by a primary amine in hydrofluoric medium. By contacting the aqueous with the amine in a separatory funnel, the organic picks up 40 to 45 g/l of Nb_2O_5. The presence of H_2SO_4 in the feed suppresses the extraction of Fe, Ti, and Mn, resulting in a purer Nb product in the organic phase. Scrubbing is done with dilute sulfuric acid and stripping with a 10% ammonium bifluoride solution. The very low solubility of the long-chain amine in the aqueous phase and the amine's low volatility (compared with other extractant systems) makes it a very economical extracting agent for Nb. (Metals Abstr.)

20032 USE OF ION EXCHANGE FOR PRODUCTION AND RECOVERY OF HIGH-PURITY POTASSIUM FLUOTANTALATE. Bielecki, E. J.; Mosheim, C. E.; Nessle, G. J. TMS Paper No. A71-57. New York; American Institute of Mining, Metallurgical, and Petroleum Engineers (1971). 15p. $3.00.

Ion exchange techniques were reviewed for separations of Ta and Nb to establish a base for developing a potentially commercial process for their recovery from ores, concentrates, slags, residues, or diluent solutions from chemical processing. The anion exchange separation in fluoride media was investigated. The effects of resin cross-linkage, particle size, and elution temperature were studied. Use of recycling techniques for dilute eluates to the succeeding cycle decreased operating costs and increased eluate concentrations. Potassium fluorotantalate was recovered by addition of a soluble potassium salt to the eluate. Niobium was recovered by precipitation of eluate with ammonia. Eluants were regenerated from solutions resulting from recovery of Nb and/or Ta fractions. Tantalum was further recovered from mother liquors from potassium fluorotantalate and other dilute process streams. (Metals Abstr.)

20033 PROPOSED ROUTE FOR THE CO-EXTRACTION OF URANIUM AND THORIUM FROM SULFURIC ACID SOLUTIONS AND RECOVERY BY SELECTIVE STRIPPING AND DENITRATION. Ritcey, G. M.; Lucas, B. H. TMS Paper No. A71-62. New York; American Institute of Mining, Metallurgical, and Petroleum Engineers (1971). 21p. $3.00.

Thorium and the rare earths are found associated with U at Elliot Lake, one of the major U-producing areas in Canada. Uranium is recovered by ion exchange and the resultant barren solution is neutralized to remove Th prior to rare earth processing. The work described shows that U and Th can be co-extracted from an acid sulfate solution using a primary amine such as Premene JM-T. It is proposed to remove trace amounts of co-extracted Fe from the loaded extract with dilute nitric acid, and recover the Th and U by selective stripping or bulk stripping with nitric acid. Uranium is separated from Th in a small solvent extraction circuit using tributyl phosphate. Finally UO_3 and thorium sulfate are produced by denitration. The comparative economics of two solvent extraction routes for the corecovery of U and Th are given. (Metals Abstr.)

20034 METHODS OF GROUP CONCENTRATION OF IMPURITIES FOR ANALYSIS OF RARE METALS AND SEMICONDUCTOR MATERIALS. Goryushina, V. G. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 5, 651-7(May 1971).
Translated from Zavod. Lab., 37: No. 5, 513-18(May 1971).

The concentration of groups of impurities in the analysis of rare metals and semiconductor compounds is reviewed on the basis of papers published in the world over the last 20 years. The results are summarized in the form of tables indicating the method of concentrating impurities together with the literature reference for each particular set of impurities and parent metal. Nearly 60 such methods are given, 23 elements and compounds being treated. Lists of the impurities precipitated by each mode of concentration are given. (99 references) (Metals Abstr.)

20035 PROCESS OF SEPARATING YTTRIUM FROM LANTHANIDE RARE EARTHS. Mason, George W.; Lewey, Sonia; Bollmeier, Allen F.; Peppard, Donald F. (to United States Atomic Energy Commission). U. S. Patent 3,615,171. 26 Oct 1971. Filed 15 Jun 1970.

Yttrium values are separated from lanthanide rare earth values, which are present together as bromides in an aqueous feed solution containing excess bromide ions, by extracting the lanthanide rare earth values and some of the yttrium values from the feed solution with bis-(2-ethylhexyl)chloromethylphosphonate, scrubbing the yttrium values from the extractant with an aqueous scrub solution of hydrogen bromide and lithium bromide, and separating the yttrium values from the aqueous feed and scrub solutions. (Offic. Gaz.)

20036 SCANDIUM SORPTION BY ION EXCHANGERS FROM MIXTURES OF MINERAL AND ORGANIC ACIDS. Isaeva, L. B.; Belyavskaya, T. A.; Brykina, G. D. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 5, 586-9(Sep-Oct 1971). (In Russian).

Scandium sorption from water–acetone mixtures of mineral (H_2SO_4) and organic ($H_2C_2O_4$ and $H_2C_4H_4O_6$) acids by cation exchanger KU-2-H and anion exchanger AV-17 was investigated within a wide range of concentrations. The nature of the acids employed, their concentrations, and acetone concentration were found to affect scandium sorption. The correlation between ion exchange and complexing was established. (auth)

20037 ELECTROPHORESIS OF INORGANIC ANIONS ON THE ANION-EXCHANGE PAPER. Tokutomi, Masayoshi; Kamiya, Seigo (Yamaguchi, Univ., Japan). Jap. Anal.; 21: No. 1, 81-7(Jan 1972). (In Japanese).

For the purpose of the separation of common inorganic anions, their electrophoretic behaviors were examined on the anion-exchange paper, Amberlite WB-2 (weak base) and SB-2 (strong base). The electrophoresis was carried out on the anion-exchange paper of 2.5 × 4.5 cm size under the constant current densities, using H_3PO_4–Na_2HPO_4 and CH_3CO_2H–CH_3CO_2Na buffer solutions of pH 4 and 7 (total concentration was 0.5M) as supporting electrolytes. The migration distance of an ion varies with the position of the starting point and other conditions. In the preliminary experiments the conditions which gave the reproducible migration distance were found; thereafter, the following conditions were employed: starting point of migration, 7.5 cm from cathode electrolyte; current density, 20 mA/2.5 cm (paper width); migration time, 60 min. Although the electromigration distance of the anion on the anion-exchange paper was less than that on the filter paper, each ion could be detected more easily in the former case than in the latter because of the smaller spot area. Since the anion-exchange resin impregnated in paper has a restraining effect on the migration of anion, the anion migrates more on WB-2 than on SB-2, and the anion having the lower selectivity coefficient on the anion-exchange resin migrates more than that having the higher one. The results obtained in the single ion migration of 20 species of common anions suggested the possibility of mutual separation of the following anions within the groups shown: (1) F^-, Cl^-, Br^-, I^-; (2) Cl^-, ClO^-, ClO_3^-, ClO_4^-; (3) SO_4^{2-}, $S_2O_3^{2-}$, SO_3^{2-}; (4) NO_2^-, NO_3^-. (auth)

20038 ANION-EXCHANGE SEPARATION OF VANADIUM AND MOLYBDENUM IN ALKALINE SOLUTIONS. Matsui, Haruo (Government Industrial Research Inst., Nagoya, Japan). Jap. Anal.; 21: No. 1, 96-8(Jan 1972). (In Japanese).

A method for the separation of vanadium(V) and molybdenum(VI) on ion-exchange resins was investigated in sodium hydroxide solutions. Distribution coefficients for these ions with strongly basic anion-exchange resins, DIAION SA No. 100 of 100 to 200 mesh in the hydroxide form, were measured at various concentrations of sodium hydroxide solutions. Both of these ions were adsorbed strongly on the resins below pH 12.0, but in the range from pH 12.0 to 2.0M, the distribution coefficients of vanadium(V) decreased sharply with the increasing of sodium hydroxide concentrations and not adsorbed in 2.0M solution, while that of molybdenum(VI) decreased slowly. (auth)

20039 FOAM SEPARATION OF ANIONS: HYDRATION, ENTROPY, AND SELECTIVITY. Grieves, R. B.; Bhattacharyya, D. (Univ. of Kentucky, Lexington). Anal. Lett.; 4: No. 9, 603-12(Sep 1971).

A selectivity coefficient for the foam separation of $Fe(CN)_6^{4-}$, $Ag(S_2O_3)_2^{3-}$, $Cr_2O_7^{2-}$, CrO_4^{2-}, $S_2O_3^{2-}$, HPO_4^{2-}, and I^- from solutions containing ethylhexadecyldimethylammonium bromide is related to the absolute partial molal entropy of each ion. The entropy, which correlates well with the degree of hydration, enables an estimate of the selectivity of an ion flotation or foam fractionation by a surfactant. (auth)

20040 INVESTIGATION OF THE STATE OF DISSOLVED NIOBIUM BY EXTRACTION CHROMATOGRAPHY IN THE SYSTEM TRI-n-OCTYLAMINE–HCl. Mymrik, N. A.; Gibalo, I. M. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 6, 738-40(Nov-Dec 1971). (In Russian).

The charge on a Nb–tertiary amine complex was determined, and the polymerization factor of the Nb chloride complex were determined by extraction chromatography. A column of ion exchange resin was used which had been treated with a 0.5 M of tri-n-octylamine in benzene. Absorption behavior of Nb chloride in HCl solutions showed that the doubly charged complex $NbOCl_5^{2-}$ was the extractable form. In 11M HCl niobium exists essentially as a monomer in the concentration range from 10^{-15} to 5×10^{-2} g · atom/l; in 7.2M HCl and at higher Nb concentrations polymerization occurs and the polymerization factor increases to two. (K.S.W.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 20711 and 20771.

20041 RELATIONSHIPS BETWEEN DIFFUSION COEFFICIENTS IN A THREE-COMPONENT SYSTEM IN WHICH TWO COMPONENTS ARE ISOTOPICALLY RELATED. Woolf, L. A. (Australian National Univ., Canberra). J. Chem. Phys.; 56: No. 5, 2489-90(1 Mar 1972).

20042 STANDARD FREE ENERGY OF TRANSFER OF POTASSIUM CHLORIDE FROM LIGHT TO HEAVY WATER FROM SOLUBILITIES OF SPARINGLY SOLUBLE SALTS. Salomaa, Pentti; Mattsen, Marja (Turku Univ., Finland). Acta Chem. Scand.; 25: 361-3(1971).

The solubilities of potassium and thallium(I) picrates in H_2O and D_2O at 25°C are measured. The solubility products of these sparingly soluble salts give the standard free energy changes for the processes IV and V.

$$K^+(H_2O) + Pi^-(H_2O) = K^+(D_2O) + Pi(D_2O) \quad (Pi^- = \text{picrate anion}) \quad (IV)$$

$$Tl^+(H_2O) + Pi^-(H_2O) = Tl^+(D_2O) + Pi^-(D_2O) \quad (V)$$

$$Tl^+(H_2O) + Cl^-(H_2O) = Tl^+(D_2O) + Cl^-(D_2O) \quad (VI)$$

Combining these results with that for VI give a value of 880 ± 75 J/mol for the free energy of transfer KCl, (I).

$$K^+(H_2O) + Cl^-(H_2O) = K^+(D_2O) + Cl^-(D_2O) \quad (I)$$

The value agrees well with a value of 900 ± 40 J/mole obtained by measuring the EMF of cells without liquid junction but is in contrast to a value of 525 ± 50 J/mole obtained from the EMF of a cell with liquid junction. (Denmark)

Chemical and Physical-Chemical Properties

Refer also to abstracts 20155, 20156, 20160, 20194, 20762, 20780, and 20821.

20043 ADDUCTS OF URANIUM TETRAHALIDES AND ORGANIC NITRILES. Gans, Peter; Marrriage, John (Univ. of Leeds, Eng.). J. Chem. Soc., A; No. 1, 46-7(1972).

The compounds UX_4, 4RCN with X = Cl, Br, R = Me, Et, Pr^n, Pr^i, Bu^n, and Ph and UX_4, $3Bu^tCN$ were prepared. The visible spectra and magnetic properties of the 4:1 adducts are consistent with an eight-coordinate configuration at the uranium atom. (auth)

20044 Ni–NiO REFERENCE ELECTRODE OF THE THIRD KIND FOR MOLTEN FLUORIDES. Hitch, B. F.; Baes, C. F. Jr. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 34: No. 1, 163-9(Jan 1972).

An electrode of the third kind consisting of a nickel wire immersed in molten $2LiF-BeF_2$ containing excess NiO and BeO was investigated. A low concentration of dissolved Ni^{2+} was produced by saturation of the melt with this oxide mixture, and this resulted in an electrode considerably less oxidizing than previously used $Ni^{2+}|Ni^0$ electrodes. The reliability of the NiO electrode, which may be represented as $Be^{2+}|NiO, BeO, Ni^0$, was established by potentiometric measurements vs the $Be^{2+}|Be^0$ electrode in the cell $Be^0|LiF(0.667), BeF_2(0.333)|NiO(c), BeO(c)|Ni^0$ the assumed cell reaction being $Be^0(c) + NiO(c) = BeO(c) + Ni^0(c)$. The measured potentials were fitted by least squares to the expression $E^0 = A + BT$ (with B assigned from available entropy and heat capacity data), giving $E^0 = 1.9075 - 0.000056T$ (T = 780–980°K). The average deviation from this expression was 2.1 mV. The magnitude of E^0 was in the range expected from available thermochemical values for BeO and NiO. (auth)

20045 STATISTICAL THERMODYNAMICS: ENTHALPY, FREE ENERGY, ENTROPY, AND HEAT CAPACITY OF SOME HEXAFLUORIDES OF OCTAHEDRAL SYMMETRY. Nagarajan, G.; Brinkley, Donald C. (Valdosta State Coll., Ga.). Z. Naturforsch.; 26a: No. 10, 1658-66(Oct 1971).

A detailed analysis of the molecular structural data and infrared absorption and Raman spectra of the hexafluorides of sulfur, selenium, tellurium, molybdenum, technetium, ruthenium, rhodium, tungsten, rhenium, osmium, iridium, platinum, uranium, neptunium, and plutonium was made. These molecules, having the greatest number of symmetry elements of all existing molecules, possess an octahedral symmetry with the symmetry point group O_h. They give rise to six fundamental frequencies of which three are allowed in the Raman spectrum, two are allowed in the infrared absorption spectrum, and one is inactive. The inactive mode is normally determined from the overtones and combinations. On the basis of a rigid rotator and harmonic oscillator model, enthalpy, free energy, entropy, and heat capacity for temperatures from 200 to 2000°K were computed for these molecules. The results are briefly discussed and compared with available experimental data. (auth)

20046 KINETICS OF THE Ce(IV)–Sn(II) REACTION. El-Tantawy, Y. A.; Abu-Shady, A. I. (Kuwait Univ.). Z. Phys. Chem. (Frankfurt); 76: No. 3-4, 154-67(Nov 1971).

The kinetics of the reaction $2Ce(IV) + Sn(II) = 2Ce(III) + Sn(IV)$ were studied in the presence of perchloric acid plus a wide range of concentrations of Na_2SO_4, $NaHSO_4$, or H_2SO_4. Over a temperature range from 15 to 30°C the reaction followed Arrhenius behavior with an activation energy of 6,700 calories per mole. A probable reaction path involving, prior to the net transfer of electrons, the formation of a transient-intermediate complex, is proposed. The rate law derived is,

$$-\frac{d[Ce(IV)]}{dt} = \frac{K_1k_2[H^+]}{[HSO_4^-]} \cdot [Ce(SO_4)_2^-][Sn(II)],$$

which explained satisfactorily all experimental observations. The second order rate constant k_{II} is $(K_1k_2[H^+]/[HSO_4^-])$, at constant concentration of HSO_4^-, given by $k_{II} = a[H^+]^{-1} + c + b[H^+]$. At least in relatively high acid concentrations the $b[H^+]$ term is predominant. (auth)

20047 RADIOCHEMICAL STUDY OF THE SORPTION OF TRACE ELEMENTS. VIII. ADSORPTION OF YTTRIUM ON GLASS AND THE EFFECT OF LOW CONCENTRATIONS OF IRON. Kucera, J.; Benes, P. (Technical Univ., Prague). Collect. Czech. Chem. Commun.; 36: No. 12, 3939-46(Dec 1971).

The adsorption and desorption of traces of yttrium ($c < 10^{-9}$ to 10^{-5} M), labeled with ^{88}Y, on glass were studied in relation to pH and composition of the solution, concentration of yttrium, and time. On the basis of the data obtained, a probable mechanism of the adsorption is proposed. In the pH range from 3.5 to 10 yttrium ($c < 10^{-9}$ M) is adsorbed on glass by an ion exchange of yttric ions, and physically in the form of pseudocolloids. The role of the physical adsorption increases with pH and strongly predominates above pH 10. Particles of colloidal yttrium hydroxide are adsorbed on glass electrostatically or physically from solutions of higher concentrations of yttrium at pH > 8. The adsorption of yttrium on glass is strongly suppressed by the presence of Fe(III) ($c\ 3.10^{-5}$ M), which is due mainly to coprecipitation of yttrium with colloidal ferric hydroxide. (auth)

20048 DETERMINATION OF THE DIFFUSION COEFFICIENT OF NICKEL(II) IN MOLTEN $LiF-BeF_2-ZrF_4$ BY LINEAR SWEEP VOLTAMMETRY AND CHRONOPOTENTIOMETRY. Manning, D. L. (Oak Ridge National Lab., Tenn.); Mamantov, Gleb. High Temp. Sci.; 3: No. 6, 533-6(Nov 1971).

The diffusion coefficient of nickel(II) in molten $LiF-BeF_2-ZrF_4$ (65.6–29.4–5.0 mole %) was evaluated by linear sweep voltammetry and chronopotentiometry. Values obtained at 500°C are 1.07×10^{-6} and 1.05×10^{-6} cm^2/sec, by voltammetry and chronopotentiometry, respectively. Essentially the same values were obtained at pyrolytic graphite and platinum indicator electrodes. (auth)

20049 CHEMISTRY OF RARE EARTHS IN MOLTEN ALKALI METAL HALIDES. VIII. INVESTIGATION OF THE PHASE DIAGRAMS OF LANTHANUM(III) IODIDES IN MIXTURES WITH ALKALI METAL IODIDES. Kutscher, J.; Schneider, A. (Technical Univ., Clausthal-Zellerfeld, Ger.). Z. Anorg. Allg. Chem.; 386: No. 1, 38-46(Dec 1971). (In German).

Phase diagrams of the binary systems RI_3-MeI (R = La, Pr, Nd, Sm, Gd, Dy, Er; Me = Na, K, Cs) were investigated by means of a differential thermal analysis method for use in fuel reprocessing studies. (auth)

20050 MECHANISM FOR THE APPEARANCE OF INTERNAL VIBRATIONS OF THE LIGANDS IN THE LUMINESCENCE SPECTRA OF URANYL COMPOUNDS. Alikhanov, Z. M.; Zolin, V. F.; Rozman, S. I.; Fisher, P. S.; Ellert, G. V. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 2, 177-8(Aug 1971).

Translated from Opt. Spektrosk.; 31: No. 2, 325-7(Aug 1971).

It is shown that the intensity of the internal vibrations of the ligands (in particular, C–H extension vibrations) depends on the mutual orientation of the uranyl group and the displacement of the ligand atoms. The intensity is greatest with a parallel orientation of the uranyl group and the displacement and is determined by the electrostatic interaction. (D.L.C.)

20051 REACTION MODEL FOR THE FLUORINATION OF URANIUM AND PLUTONIUM COMPOUNDS IN FLUIDIZED-BED REACTORS. Anastasia, Louis J.; Alfredson, Peter G.; Steindler, Martin J. Ind. Eng. Chem., Process Design Develop.; 10: No. 2, 150-7(Apr 1971).

The fluorination of solid U and Pu compounds to yield a gaseous product (UF_6 and PuF_6) in a fluidized bed of alumina follows a simple reaction model of a continuously diminishing spherical interface with chemical-reaction rate controlling. The fluidized-bed reactor is used to promote isothermal conditions for the reactions, which are highly exothermic. Experiments were performed utilizing reactors of 2- or 3-in diameter. In some experiments, UO_2 pellets were reacted directly with dilute F; however, in a typical experiment, the charge was reacted with dilute O to form U_3O_8, or U_3O_8/PuO_2 powder, which was then reacted with either dilute F or BrF_5 to form volatile UF_6. The volatile PuF_6 product was formed by subsequent reaction with concentrated F. The success of the application of the simplified reaction model does not preclude a complicated reaction mechanism, e.g., UO_2F_2, UF_4 and PuF_4 are known to be present; it does, however, offer promise for reactor design and scale-up for these exothermic, heterogeneous reactions carried out under isothermal conditions. (Metals Abstr.)

20052 DISTRIBUTION OF URANYL NITRATE AND NITRIC ACID BETWEEN AQUEOUS SOLUTIONS AND 30 VOLUME PERCENT TRIBUTYL PHOSPHATE IN HYDROCARBON DILUENT. Goldberg, Stephen M.; Benedict, Manson; Levi, Hans W. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 47: No. 2, 169-86(Feb 1972).

Equations, tables, and charts are given, which represent the equilibrium distribution of uranyl nitrate and nitric acid between aqueous solution and an organic phase consisting of 30 vol.% tributyl phosphate (TBP) in a hydrocarbon diluent at 25°C. These should be useful for prediction of distribution equilibria in the Purex solvent extraction process for recovering uranium from irradiated nuclear fuel. Equations for the aqueous phase represent the activities of water, nitric acid, and uranyl nitrate hexahydrate as functions of the molality of the last two components. These equations were developed by correlating data for the partial pressure of nitric acid over aqueous solutions of nitric acid and uranyl nitrate. Distribution equilibrium data for uranyl nitrate are correlated by an equation representing the ratio of the activity coefficient of the uranyl nitrate–TBP complex to the activity coefficient of uncomplexed TBP as a function of the uranyl nitrate and nitric acid content of the organic phase. This equation was fitted to distribution data for uranyl nitrate observed in the presence of nitric acid and in the absence of nitric acid. The observed molality of uranyl nitrate in the organic phase agrees with the molality predicted by this equation within an average deviation of 5.8%. Distribution equilibrium data for nitric acid in the presence of uranyl nitrate were correlated in analogous fashion. (auth)

20053 CHEMISTRY OF THE TRANSURANIUM ELEMENTS. Keller, Cornelius. Kernchemie in Einzeldarstellungen. Volume 3. Weinheim, Ger.; Verlag Chemie GmbH (1971). 689p.

The book is divided into two parts. The first part treats the group of transuranium elements as a whole, including a discussion of their preparation, use, and properties within the broader framework of the actinide elements. Similarities and differences in the behavior of the 5f-elements are discussed. The second part deals with the individual transuranium elements neptunium (Z = 93) to hafnium (Z = 105), emphasizing the properties and characteristics of each element. Physical and nuclear physical properties, as well as chemical properties, are discussed in detail. (J.G.B.)

20054 PREPARATION OF SODIUM o-(N-HYDROXY-N-PHENYLCARBAMOYL)BENZENESULFONATE AND REACTIONS WITH METAL IONS. Bhargava, S. P.; Sogani, N. C. (Univ. of Rajasthan, Jaipur, India). Bull. Chem. Soc. Jap.; 44: No. 10, 2840(Oct 1971).

Sodium o-(N-hydroxy-N-phenylcarbamoyl)benzenesulfonate (indexed as the sodium salt of N-phenyl-o-sulfobenzohydroxamic acid) was prepared by allowing o-sulfobenzoic anhydride to react with phenylhydroxylamine. The colors of the complexes formed when the reagent was reacted with U, Mo, Ru, and some other metal ions are given; no color appeared when reacted with Th, Zr, Ce, La, and some other metal ions. (J.G.B.)

20055 PHYSICS AND CHEMISTRY WITH HEAVY IONS. III. ATOMIC PHYSICS AND CHEMISTRY. Fricke, B. (Northwestern Univ., Evanston, Ill.); Scheid, W. Kerntech. Atomprax.; 13: No. 10, 443-7(Oct 1971). (In German and English).

The construction of a heavy ion accelerator will open the possibility of experimental study of problems in various fields beside nuclear physics. In the field of atomic physics, research into highly charged ions, x-ray spectroscopy, and the related measurement of quantum electrodynamic effects become particularly important and interesting in the range of super-heavy elements. From the chemical point of view, these elements are expected to possess a number of behavior patterns unknown so far. Some predictions extending as far as element 172 are discussed. (auth)

Isotope Effects

Refer also to abstracts 20078 and 20161.

20056 (COO-3313-2) ANOMALOUS KINETIC HYDROGEN ISOTOPE EFFECTS ON THE RATE OF IONIZATION OF SOME ALKYL SUBSTITUTED KETONES. Lynch, R. A.; Vincenti, S. P.; Lin, Y. T.; Smucker, L. D.; Subba Rao, S. C. (Lincoln Univ., Pa. Dept. of Chemistry). [nd]. 2p. Dep. NTIS.

Measurements were made on the kinetics of hydroxide-catalyzed rates of H, D, and T transfer to water from ketones. Deuterium isotope effects were observed. (M.C.G.)

20057 (TID-25926) ANOMALOUS KINETIC HYDROGEN ISOTOPE EFFECTS ON THE RATE OF IONIZATION OF SOME DIALKYL SUBSTITUTED KETONES. Lynch, R. A.; Vincenti, S. P.; Lin, Y. T.; Smucker, L. D.; Subba Rao, S. C. (Lincoln Univ., Pa. Dept. of Chemistry). [1971]. Contract AT(30-1)-4254. 26p. Dep. NTIS.

The rates of H, D, and T exchange between ketones and water were measured. The Arrhenius plots were linear and the deuterium isotope effects were normal. (M.C.G.)

20058 SOLVENT ISOTOPE EFFECTS: SECOND THOUGHTS ABOUT AN OLD PROBLEM. Halevi, E. A. (Technion-Israel Inst. of Tech., Haifa). Israel J. Chem.; 9: No. 3, 385-95(1971).

From twenty-second Farkas memorial symposium; Jerusalem, Israel (29 Dec 1970).

The commonly held Gross–Butler theory of isotope effects in mixed H_2O-D_2O solvents was reexamined. Special attention was given to the conventional separation of the free energy changes responsible for the isotope effect into contributions from "transfer" and "exchange". The internal inconsistency of the theory is pointed out and its empirical utility is questioned. (auth)

20059 MASTER EQUATION FOR THE DISSOCIATION OF A DILUTE DIATOMIC GAS. V. EFFECT OF ENERGY-LEVEL SPACING. McElwain, D. L. S.; Pritchard, H. O. (York Univ., Downsview, Ont.). Can. J. Chem.; 49: No. 23, 3915-7(1 Dec 1971).

Previous vibration–dissociation coupling calculations for H_2 were repeated for D_2. Closer spacing of the vibrational energy levels in D_2 leads to increased translation–vibration transition probabilities, and the effect of this is to increase the rate of recombination by the vibrational mechanism at all temperatures. These numerical experiments also clarify two other issues: (i) that the position of the bottleneck does not necessarily occur at that level above which direct collisional dissociation can take place rapidly, and (ii) that there is no simple correspondence between the position of the bottleneck and the Arrhenius temperature coefficient for dissociation. (auth)

20060 SOME CHEMICAL CONSEQUENCES OF MAGNETIC INTERACTIONS IN RADICAL PAIRS. Lawler, R. G.; Evans, G. T. (Brown Univ., Providence). Ind. Chim. Belge; 36: No. 12, 1087-9(1971).

Since the radical pair model for chemically induced dynamic nuclear polarization (CIDNP) is based on the hypothesis that nuclear spins affect the reactivity of pairs of radicals in solution, it is natural to ask whether these effects might be detectable by means other than magnetic resonance. It is the purpose here to suggest that at least three additional kinds of detectably large effects of this kind might be expected: (a) variation of cage effect with initial electron spin multiplicity, especially unexpectedly high reactivity of pairs generated in the triplet state; (b) secondary kinetic isotope effects on radical combination efficiencies; and (c) variation of cage effect with externally applied magnetic field. (auth) (Belgium)

20061 KINETIC ISOTOPE EFFECT STUDIES ON THE REACTION OF BENZYL NITRATE WITH BASE IN VARIOUS SOLVENTS. Pollock, C. A.; Smith, P. J. (Bishop's Univ., Lennoxville, Quebec). Can. J. Chem.; 49: No. 23, 3856-65(1 Dec 1971).

The effects of solvent and base on the nature of the transition state for the concerted one-step carbonyl elimination reaction of benzyl nitrate were examined using rate and kinetic isotope effect techniques. The primary hydrogen–deuterium isotope effect was found to increase with increasing strength of the abstracting base, k^H/k^D = 5.94 and 6.41 at 30°C for reaction with EtO^-/EtOH and t-BuO^-/t-BuOH, respectively. The nitrogen isotope effect decreased with increasing strength of the abstracting base, 2.07, 1.82, and 1.54% for reaction with OH^-/40 vol % $EtOH-H_2O$, EtO^-/EtOH, and t-BuO^-/t-BuOH, respectively. It was concluded that an increase in the strength of the abstracting base leads to a more reactant-like transition state with decreased rupture of both the C–H and O–N bonds. The effect of solvent on the nature of the transition state was examined by determining rates and nitrogen isotope effects for reaction in various ethanol-water and ethanol-dimethyl sulfoxide mixtures. The nitrogen effect was found to remain essentially constant in solvent mixtures ranging from 65 vol % $EtOH-H_2O$ on the one hand to 80 vol % EtOH–DMSO on the other hand where the rate constants differed by a factor of 100 fold. It was concluded that solvent plays only a very minor role in determining transition state structure for the concerted elimination reaction of a neutral substrate with base. (auth)

20062 VAPOR PRESSURE ISOTOPE EFFECT IN AQUEOUS SYSTEMS. I. H_2O-D_2O (-64^0 TO 100^0) AND $H_2{}^{16}O-H_2{}^{18}O$ (-17^0 TO 16^0); ICE AND LIQUID. II. ALKALI METAL CHLORIDE SOLUTION IN H_2O AND D_2O (-5^0 TO 100^0). Pupezin, Jovan; Jakli, Gyorgy; Jancso, Gabor; Van Hook, Alexander (Univ. of Tennessee, Knoxville). J. Phys. Chem.; 76: No. 5, 743-62(2 Mar 1972).

High precision data are reported over a broad temperature range for the vapor pressure isotope effects displayed by the systems $H_2{}^{16}O-H_2{}^{18}O$; H_2O-D_2O; H_2O-D_2O–NaCl (1.1, 2.9, 4.0, and 5.5 m); H_2O-D_2O–KCl (3.5 and 4.5 m); H_2O-D_2O–CsCl (1.0, 3.0, 4.5, and 6.0 m); and H_2O-D_2O–LiCl (3.0, 5.0, 7.0, and 15.0 m). Here m is the concentration in aquamolality. The results are summarized with analytical expressions reported in the text and are good to ±0.0003 in R unit or better (R is the isotopic pressure ratio). For the solutions the data extend from about 0 to 90° except for KCl where the lower bound is 20°C. The pure deuterium oxide system was investigated in both the ice and liquid phases in the region between –64 and 100°C, but the measurements on ^{18}O labeled water were limited to a narrower temperature range. For the pure waters, agreement with earlier workers was satisfactory and extends to the predicted triple points and ice-liquid fractionation factors. The analytical expressions for the temperature dependence of the vapor pressure isotope effects reported here are regarded as the best now available. For the salt solutions expressions for the change in the vapor pressure isotope effect as a function of concentration and temperature and expressions for the isotope effects on the excess thermodynamic properties of solution are extracted from the data (including isotope effects on the osmotic and the activity coefficients, and the excess free energies, enthalpies, entropies, and heat capacities of solution). The isotope effects on the standard thermodynamic properties of solution are also determined where possible (NaCl and KCl). A useful minor facet of the work is the least-square analysis of literature data on the osmotic and activity coefficients of KCl and CsCl to give expressions for these quantities reliable within ±0.01 unit between 0.5 m and saturation over our temperature range. The solution data are compared with those from other laboratories where available (almost all only at 25°C). They are discussed briefly in terms of models of solution structure. (auth)

20063 ISOTOPE EFFECTS IN PARAELECTRIC RELAXATION. Baur, H.; Knop, K.; Meier, P.; Serrallach, E. (Eidgenoessische Technische Hochschule, Zurich). Phys. Kondens. Mater.; 14: No. 1, 15-20(1971).

Through measurements of the complex dielectric susceptibility in the temperature range between 0.3°K and a few °K the influence of the isotopic substitutions H → D and $^{16}O \rightarrow {}^{18}O$ on the relaxation time of the hydroxyl dipole in weakly doped KBr and RbCl was studied. The H → D effect is present in both host lattices. The oxygen effect, however, is only for RbCl outside experimental error, indicating that in this host lattice the reorientation of the hydroxyl ion involves a considerable displacement of its center of mass. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstracts 20108, 20138, and 20534.

20064 (COO-3263-1) SEPARATION OF ISOTOPES. Annual Progress Report. Ghate, M. R.; Mathur, B. P.; Saltamach, V. G.; Taylor, T. I. (Columbia Univ., New York. Dept. of Chemistry). 1 Nov 1971. Contract AT(11-1)-3263. 76p. Dep. NTIS.

Summaries of reports on isotope separation are included. Data and tests for design of a cascade system to concentrate ^{13}C by chemical exchange between CO_2 and amine carbamate are discussed. Circuit diagrams for level-controlling units using thermistors and photoelectric cells are given. (M.C.G.)

20065 (MLM-1873(TR)) KINETICS OF HETEROGENEOUS ISOTOPE EXCHANGE REACTIONS. Lieser, K. H. Translated for Mound Lab., Miamisburg, Ohio, from Monatsh. Chem.; 101: 1630-8(1970). 13p. Dep. NTIS.

The partial steps of heterogeneous exchange reactions between a solid and a solution or gas phase are discussed, and corresponding rate equations given. The exchange reactions investigated so far between ion crystals and ions in solution are determined by the displacement reaction (2nd order reaction) at the surface. For the isotope exchange between sodium iodide and gaseous methyl iodide, desorption of methyl iodide at the surface is rate determining. In this reaction increasing temperature leads to the participation of more and more surface layers in the rapid surface exchange while the activation energy for the exchange with the deeper lying layers rises continuously. (auth)

20066 HYDROGEN–DEUTERIUM EXCHANGE IN THE METHYL GROUP OF FOUR BISDIMETHYLGLYOXIMATOCOBALT(III) COMPLEXES. Yoneda, Hayami (Wakayama Univ., Japan); Takagi, Ichiro; Morimoto, Yukiyoshi. Bull. Chem. Soc. Jap.; 44: No. 12, 3493(Dec 1971).

A hydrogen–deuterium exchange in the methyl group of a series of bisdimethylglyoximatocobalt(III) complexes is reported. The exchange rate is dependent on the kind of axial ligand. The exchange rate for the free ligand was negligibly small, compared with that of any one of the four complexes tested, and it was concluded that the activation of ligand protons is induced by chelation. (M.C.G.)

20067 METHANE DEUTERIUM EXCHANGE ON GRAPHITE–POTASSIUM LAMELLAR COMPOUNDS. Ichikawa, Masaru (Sagami Chemical Research Centre, Sagamihara, Japan); Kawase, Kohei; Tamaru, Kenzi. J. Chem. Soc., D; No. 3, 177(9 Feb 1972).

A step-wise hydrogen exchange between deuterium and paraffins, such as methane, was found to take place over graphite–potassium lamellar compounds at ca 300°C. (auth)

20068 ION-MOLECULE REACTIONS IN ISOTOPIC HYDROGEN BY ION CYCLOTRON RESONANCE. Clow, Roger P.; Futrell, Jean H. (Univ. of Utah, Salt Lake City). J. Mass. Spectrom. Ion Phys.; 8: No. 2, 119-42(Feb 1972).

Ion–molecule reactions of hydrogen, deuterium, and hydrogen deuteride $H_2^+ + H_2 \rightarrow H_3^+ + H$, $D_2^+ + D_2 \rightarrow D_3^+ + D$, $HD^+ + HD \rightarrow H_2D^+ + D \rightarrow HD_2^+ + H$ and the crossed reactions $H_2^+ + D_2 \rightarrow H_2D^+ + D \rightarrow HD_2^+ + H$, and $D_2^+ + H_2 \rightarrow H_2D^+ + D \rightarrow HD_2^+ + H$ were studied using ion cyclotron resonance techniques. Thermal rate constants were measured for these reactions, which are generally in accord with previous experimental measurements and in excellent agreement with calculations based on simple Langevin polarization theory. Multiple resonance and multiple pulse techniques were used to evaluate isotope effects and effects of ion kinetic energy on these reactions. New reaction channels of dissociative proton transfer and charge transfer become open with increasing translational energy. These results are rationalized in part by statistical phase space theory and in part by simplified models involving orientation effects and separation of centers of mass and charge in HD^+. (auth)

20069 SEPARATION OF NITROGEN AND HYDROGEN ISOTOPES DURING PHOTODISSOCIATION OF AMMONIA. Utirov, B. U.; Panchenkov, G. M.; Korovkin, V. K.; Basov, Yu. G. At. Energ. (USSR); 32: No. 2, 169-70(Feb 1972). (In Russian).

The photodissociation of pure ammonia was conducted in a cylindrical container with Mo walls, arranged for exposure to a Hg lamp. The resulting change in pressure of the system was used to estimate the rate of reaction. The initial temperature of the thermostatted system ranged from –20 to +30°C, and the initial pressures chosen were in the interval between 18 and 600 Torr. A mass spectrometer was used to determine the isotopic composition, and from the mass 28–mass 29 data the separation coefficient was calculated for nitrogen. Similarly, HD and H_2 were sought by the mass spectrograph. It was found that a redistribution of N atoms occurred during photodissociation, whereupon the rare isotope ^{15}N concentrated in the undecomposed NH_3. The mechanism is discussed and values of the coefficients are given. (K.S.W.)

20070 CALCULATION OF NON-STEADY STATE PROCESSES FOR THE SEPARATION OF MICRO-COMPONENT ISOTOPIC MIXTURES. Agrest, M. M.; Subbotin, V. M.; Partsakhashvili, G. L.; Chachibaya, Ts. Sh. Khim. Prom. (Moscow); No. 1, 56-8(Jan 1972). (In Russian).

Calculations are presented for a non-steady state separation process for a mixture of the three isotopes ^{16}O, ^{17}O, and ^{18}O in a cascade of three columns wherein low-temperature distillation of nitric oxide is accomplished. The results presented in graphic form indicate: the concentration of ^{18}O as a function of time (0 to 90 days), and the distribution of ^{18}O and ^{17}O along the cascade at various operating times. (K.S.W.)

20071 UNIVERSAL AUTOMATIC APPARATUS FOR ISOTOPE SEPARATION BY CHEMICAL EXCHANGE WITH THERMAL PHASE REVERSAL. Kuznetsov, A. I.; Panchenkov, G. M.; Makarov, A. V. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 6, 714-18(Nov-Dec 1971). (In Russian).

An automatic apparatus has been designed to separate isotopes by means of a thermally decomposable chemical complex that contains the isotopic mixture. To test the equipment N isotopes were separated by chemical exchange between NH_3 and its complex with a low-molecular-weight aliphatic alcohol ($NH_3 - NH_3 \cdot C_2H_5OH$). The complex is decomposed in a "desorber" at a relatively high temperature, and the issuing gas is fed to an "absorber" (cold-water jacket), where the complex is reformed. A separation coefficient of two is claimed for N isotopes with this device. (K.S.W.)

Feed Materials Processing

Refer also to abstracts 20147, 20313, and 20374.

20072 FLOTATION CHARACTERISTICS OF PHOSPHATIC URANIUM MINERALS. Abido, A. M. (National Research Centre, Cairo). Indian J. Technol.; 9: No. 9, 344-6(Sep 1971).

The flotation characteristics of the phosphatic uranium minerals autunite, torbernite, and parsonsite were investigated. The possibility of separating these minerals from the acid-consuming minerals calcite and dolomite by flotation using oleic acid (OLH) and potassium N-mono-n-dodecyldithiocarbamate (KMDD) as collectors was examined. The results obtained indicate that KMDD possesses better selective power than OLH, probably due to its relatively low pK_a value and its ability to form an insoluble hydrophobic compound with uranium and the uranyl cation. The selective collecting power of KMDD increases considerably in sulfuric acid medium due to the formation with calcium sites of an insoluble hydrophilic compound of the type ... $CaSO_4 \cdot 2H_2O^-$, leading to depressed flotation of calcite and dolomite. OLH causes greater separation compared to KMDD, but it is less selective, which is possibly due to the relatively high pK_a value of OLH and the extremely low dissociation constant of HCO_3^- and HPO_4^-. (auth)

20073 PROCESS FOR THE PRODUCTION OF HIGH MELTING METALS. (to Rederiaktiebolaget Nordstjernan Axel Johnson Institutet foer Industriforskning). British Patent 1,263,283. 9 Feb 1972. Priority date 9 Apr 1968, Sweden.

A process is described for producing refractory (high-melting) metals such as W, Nb, Ta, Zr, Hf, and U from ores. The process includes the steps of: reacting the ore(s) with a reducing agent to form an alloy of the refractory metal and the agent, which alloy has a melting point lower than that of the pure metal; solidifying the alloy and crushing it; treating the crushed alloy with chlorine, fluorine, or bromine; separating the refractory metal chloride, fluoride, or bromide from other chlorides, fluorides, or bromides; and reducing the refractory metal chloride, fluoride, or bromide.

The process is compact, easily controlled, and gives a very high yield, usually more than 99 or 99.5%. Tungsten made by this process is especially suitable for production of tungsten carbonyl. (P.C.H.)

20074 METHOD OF DISSOLVING URANIUM ORES IN SITU BY MEANS OF AN ELECTRIC CURRENT. Heger, Walter (to Gewerkschaft Brunhildre). German Patent 1,280,777. 19 Jun 1969. Filed 25 Jul 1967.

A method is presented for the leaching of uranium in situ using natural water under the influence of an electric current. The electrodes are mounted in the immediate vicinity of the feed points and collection points for the dissolving water, so that the portion of the seam to be dissolved is located between the electrodes. The electric current is adjusted according to the extent of the ore deposit to be leached and the quantity of dissolving water in the leaching area. (J.G.B.)

Radiation Chemistry

Refer also to abstracts 20139, 20404, 20517, 20557, 20948, 21031, and 22089.

20075 (ANL-Trans-907) RADIATIVE AND NON-RADIATIVE QUENCHING OF $O_2^+(b^4\Sigma_g^-)$ FORMED BY ELECTRON PULSING IN He + O_2 MIXTURES. Clerc, Michel; Bourene, Maurice; LeCalve, Jacques; Lesigne, Bernard. Translated for Argonne National Lab., Ill., from J. Chim. Phys.; Supp. 20th Reunion, 234-8(1969). 13p. (CONF-690566-1). Dep. NTIS.

From twentieth annual meeting of society of physical chemistry; Paris, France (27 May 1969).

Time resolved oscillographic recordings of the emission $O_2^+(b^4\Sigma_g^-) \rightarrow (a^4\Pi_u)$, (1 – 0) at 5602 Å, produced by 500-keV electron pulses (3.10^{-9}s) in O_2 + He mixtures, made it possible to measure the quenching rate constant of $O_2^+(b^4\Sigma_g^-)$ by O_2 and He, and the $O_2^+(b^4\Sigma_g^-)$ radiative lifetime. The following results were obtained: $O_2^+(b^4\Sigma_g^-) + O_2$, $k = (7.5 \pm 2.5).10^{-10}$ cm^3 molecule^{-1}s^{-1}; $O_2^+(b^4\Sigma_g^-)$ + He, $k = (7 \pm 2.5).10^{-14}$ cm^3 molecule^{-1}s^{-1}; and $O_2^+(b^4\Sigma_g^-)$ radiative lifetime is $(8 \pm 3).10^{-7}$s. The He excitation energy produced by the electron impulsion is transferred to O_2 by a fast process, which, if expressed as a bimolecular reaction, would lead to the rate constant: $k = (5.5 \pm 2.5).10^{-10}$ cm^3 molecule^{-1}s^{-1}. In a second part, the nature of the He excited species involved in this energy transfer process is discussed and finally attributed for the main part to He(2^3S), He(2^1S) and possibly to He_2^+. (auth)

20076 (NP-19192) PHYSICAL AND PHYSICO-CHEMICAL EFFECTS OF IONIZING RADIATION IN GASES. Prosser, Rose-Marie (Melbourne Univ., Parkville (Australia)). [1970]. 145p. Dep. NTIS (U. S. Sales Only).

Thesis.

The energy required to form an ion pair in a gas, W, was determined by two methods thought suitable for adaption in chemistry laboratories, using a cavity ion chamber. In the first method gamma irradiation was used for 20 gases comprising simple hydrocarbons, organic vapors and fluorocarbons. The second method involved the use of beta particle radiation from tritium and values were obtained for Ne, Ar, Xe, O_2 and ten fluorocarbons. Values obtained from this method were in good agreement with the literature, but values from the first method were generally higher. A preliminary mechanistic study of the reaction between CF_4 and tritium was also made. (M.R.M.)

20077 (RRL-3238-373) QUARTERLY REPORT, OCTOBER 1–DECEMBER 31, 1971. Fundamental Research No. 6041. (Mellon Inst. of Science, Pittsburgh, Pa. Radiation Research Labs.). 15 Jan 1972. 23p. Dep. NTIS.

Research progress in radiation chemistry is reported including abstracts of reports issued during the quarter and progress of other investigations including γ radiolysis of cyclohexane–$^{14}CH_2Br$ solutions, measurement of spin relaxation times, ESR studies of photolytically generated $\dot{SO}_4^-$, precursors of the complexed hydroperoxyl radical, radiolysis of aqueous solutions of benzene, radiation chemical studies on aqueous solutions of hydrocarbons, radiation chemistry of 5-bromocytosine in aqueous systems, and electron capture by SO_2. (D.H.M.)

20078 PROCEEDINGS OF THE TWENTY-SECOND FARKAS MEMORIAL SYMPOSIUM ON KINETICS OF REACTIONS IN AQUEOUS SOLUTIONS, JERUSALEM, DECEMBER 29–30, 1970. Perlmutter-Hayman, Berta (ed.). Israel J. Chem.; 9: No. 3, 287-427(1971). (CONF-701226).

Twelve papers presented at the symposium are included. Separate abstracts were prepared for three papers. (M.C.G.)

For abstracts of individual papers see: 20058, 20079, and 20080.

20079 SELECTIVITY IN FAST REACTIONS OF AQUEOUS OH-RADICALS WITH AMIDES. Lichtin, N. N. (Hebrew Univ., Jerusalem). Israel J. Chem.; 9: No. 3, 397-403(1971).

From twenty-second Farkas memorial symposium; Jerusalem, Israel (29 Dec 1970).

Measurement of rates of abstraction of H atoms by aqueous OH radicals from specific sites in aliphatic amides by the technique of pulse radiolysis-kinetic spectroscopy establishes that in this reaction, in which gross rates of reaction fall short of the diffusion-controlled limit by no more than a factor of 10^2, there is a systematic variation of reactivity with structure. This variation parallels dependence of reactivity on structure observed in the reactions of several other free radicals in the gas phase. (auth)

20080 APPLICABILITY OF THE BROENSTED RELATION TO REACTIONS OF THE HYDRATED ELECTRON. Stein, G. (Hebrew Univ., Jerusalem). Israel J. Chem.; 9: No. 3, 413-18 (1971).

From twenty-second Farkas memorial symposium; Jerusalem, Israel (29 Dec 1970).

The hydrated electron, e^-_{aq}, reacts with Brønsted acids, BH^+, to yield H atoms through a process of proton transfer $BH^+ + e^-_{aq} \xrightarrow{k} B + H$. For a series of Brønsted acids of charge types 1+, 0, and 1–, the rate constant, k, is related to the acid dissociation constant K according to $k/p = G_A(qK/p)^{\alpha}$, where $\alpha = 0.42$. Some acids give rate constants deviating from this relation. These are shown to be ambident reagents with e^-_{aq}, one pathway obeying the Brønsted relation, while the other may be nucleophilic addition of e^-_{aq} to a reaction center in B. Thus $-k(e^-_{aq})$, the rate of disappearance of e^-_{aq} may be greater than +k(H), the rate of formation of H atoms. To account for the results, a molecular model for the structure of e^-_{aq} forming a hydrated anion is favored. Its reaction with H^+_{aq} is discussed, accounting for recent observations on the rate of the reaction $e^-_{aq} + H^+_{aq} \rightarrow H_{aq}$, which may correspond to proton transfer to fully ordered hydrated electrons, rather than electron addition to H^+_{aq}. (auth)

20081 PARAMAGNETIC RADIATION DEFECTS IN FLUORENE AND CARBAZOLE SINGLE CRYSTALS. Kotsch, E. (Justus-Liebig Univ., Giessen, Ger.). Z. Naturforsch.; 26a: No. 11, 1836-46(Nov 1971). (In German).

Two complementary radicals in fluorene and carbazole single crystals, irradiated by uv, γ, or x rays, were identified by investigation of the hyperfine structure of ESR spectra. Species I is formed by dissociation of a hydrogen atom from position 9, whereas species II results from addition of a hydrogen atom to one of the benzene rings. In carbazole, there is evidence of a third radical. The annealing kinetics of all these radicals were proved to be of second order, requiring activation energies between 1 and 2.1 eV. (auth)

20082 DISPLACIVE MOVEMENT OF THE RADICAL IN TGS NEAR THE CURIE POINT. Kato, Terumasa; Abe, Ryuji (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 32: No. 3, 717-22(Mar 1972).

ESR spectra of γ-irradiated TGS were observed in both ferroelectric and paraelectric phases. The hyperfine splitting tensors of the rotating β-protons and the α-proton in the radical $NH_3\dot{C}HCOO^-$, were determined. The hfs tensor of the β-protons was varied when the crystal passed through the Curie point. From the temperature dependence of the spectrum, the frequency factor f_0, and the activation energy E of the rotating β protons were determined to be 5×10^{11} sec^{-1} and 0.17 eV, respectively. Near and above the Curie point, the experimental curve of log τ versus 1/T deviates from the relation $1/\tau = f_0 \exp(-E/kT)$. This means that near and above the Curie point, glycines 2 and 3 are placed at the positions of point symmetry as if they make a displacive transition and the spectral lines are superimposed. It was also found that the ESR spectrum of the radical $\dot{C}H_2COO^-$ disappeared abruptly at about 80°C, suggesting the decomposition of the radical. (auth)

20083 QUANTUM MECHANICAL TUNNELING IN HYDROGEN ATOM ABSTRACTION FROM SOLID ACETONITRILE AT 77 TO 87°K. Le Roy, Robert J. (Univ. of Toronto); Sprague, Estel D.; Williams, Ffrancon. J. Phys. Chem.; 76: No. 4, 546-51(17 Feb 1972).

Recent measurements of the rate of H-atom abstraction from solid acetonitrile at 77 to 87°K yielded an apparent activation energy of 1.4 ± 0.1 kcal/mol, much smaller than the value 10.0 ± 0.5 kcal/mol reported earlier for the same reaction occurring in the gas phase at 373 to 573°K. However, exact one-dimensional tunneling calculations for potential energy barriers of different sizes and shapes show that the two sets of results may be quantitatively understood in terms of a single gaussian-shaped potential

barrier. This means that at 77 to 87°K the reaction proceeds almost totally via quantum-mechanical tunneling. (auth)

20084 RADIOLYSIS OF ALIPHATIC CARBOXYLIC ACIDS. ON THE DECARBOXYLATION OF NORMAL ACIDS IN THE LIQUID STATE. Jones, A. Russell (Oak Ridge National Lab., Tenn.). Radiat. Res.; 48: No. 3, 447-53(Dec 1971).

The decarboxylation by gamma radiation of normal aliphatic carboxylic acids was studied in the liquid state in order to investigate the effects of temperature and chain length on the carbon dioxide yields. Contrary to an earlier report, the radiolytic yields have been found to be independent of temperature from 10 to 110°. For acids having more than 2 carbon atoms the yields decrease smoothly and continuously but progressively more slowly as the chain lengths increase. Evidence is presented to show how sharply localized is the chemical consequence of the absorption of ionizing radiations by this homologous series. It is proposed that the radiolytic decarboxylation is caused by excitation of RCOOH to an unstable electronic state which immediately fragments to form the free radicals R and H and molecular carbon dioxide. The experimental relationship between chain length and decarboxylation yield is discussed in relation to a simple model. (auth)

20085 MEASUREMENTS OF OPTICAL ABSORPTION SPECTRA UNDER ^{60}Co-γ IRRADIATION. AQUEOUS METHYLENE BLUE SOLUTIONS CONTAINING OXYGEN. Ohno, Shin-ichi; Sakumoto, Akihisa; Sasaki, Teikichi; Kawatsura, Kiyoshi; Furukawa, Katsutoshi (Japan Atomic Energy Research Inst., Tokai). Bull. Chem. Soc. Jap.; 44: No. 12, 3265-8(Dec 1971).

Aerated aqueous solutions of methylene blue (MB^+; 3×10^{-7} M) were subjected to ^{60}Co γ rays in the presence of added methanol, ethanol, or D-glucose at dose rates up to 4×10^{15} eV g^{-1} s^{-1}, and the change in the optical absorption spectrum in the 300 to 700 nm region was studied using a rapid-scan spectrophotometer (scanning speed: 30 ms/100 nm). In the presence of high concentrations (>10^{-2} M) of organic substances, it was found that radiation caused a decrease in the absorption due to MB^+ at 650 nm (the magnitude of the decrease was proportional to the radiation intensity), and that, on the removal of the radiation source, the original absorption spectrum was restored. This was interpreted as meaning that the radiation-produced leuco-form of methylene blue (MBH) was rapidly oxidized by oxygen. The rate constant, k(MBH + O_2), was estimated to be $(0.6 \pm 0.2) \times 10^4$ M^{-1} s^{-1} at neutral pH. In the absence of added organic substances, the permanent decoloration of MB^+ took place; this was interpreted as being due to the reaction of MB^+ with OH-radicals. From the competition kinetic study using 10^{-4} M methanol, the rate constant, k(OH + MB^+), was estimated to be 1.1×10^{10} M^{-1} s^{-1}. (auth)

20086 UNSTABLE INTERMEDIATES. PART CV. RADIOLYSIS OF FROZEN AQUEOUS SOLUTIONS OF ALKALI-METAL HALIDES: ELECTRON SPIN RESONANCE SPECTRA FOR MH^+ AND $HalOH^-$. Ginns, I. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc. A; No. 2, 143-7(1972).

Exposure of glassy aqueous solutions of alkali- metal halides to ^{60}Co γ rays at 77°K gave species identified by their ESR spectra as H·, MH^+, OH, $HalOH^-$, and Hal_2^-. The effect of gradual annealing is outlined and aspects of the damage mechanism discussed. The fact that H· is preferentially trapped by the metal cations while OH is trapped by the halide ions is rationalized in terms of the electronic structures of the resulting radicals. (auth)

20087 UNSTABLE INTERMEDIATES. PART CVI. γ-IRRADIATION OF FROZEN AQUEOUS SOLUTIONS OF ALKALI-METAL CYANIDES. Ginns, I. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 2, 185-7(1972).

Exposure of aqueous solutions of alkali-metal cyanides to ^{60}Co γ-rays at 77°K yields hydroxyl radicals, $(CN)_2^-$, H_2CN, and HCN^-. The magnetic parameters of these species are compared with existing data. Under these conditions the radical HCN^- is readily protonated to H_2CN even in strongly alkaline rigid solutions. Some evidence for the formation of the radical $HCNO^-$ was also obtained. If this is correct, then this radical, having $A_{iso}(^1H)$ = 78 G, is probably structurally similar to H_2CN. Possible mechanisms for the formation of these radicals are outlined. (auth)

20088 ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGE. PART V. γ-RADIOLYSIS AND PHOTOLYSIS OF AQUEOUS ALKALINE GLASSES CONTAINING ACETONITRILE. THE PHOTO CONVERSION OF AN IMINO RADICAL TO AN ALKYL RADICAL AT 77°K. Sargent, F. P.; Bailey, M. G. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Can. J. Chem.; 49: No. 23, 3898-3900(1 Dec 1971). (AECL-3937).

The reactions of γ and photochemically produced electrons with acetonitrile in 8 M sodium hydroxide glasses at 77°K were reinvestigated. The results differed from those previously reported and a novel photo-conversion of an imino radical to an alkyl radical was found. These results lead to a unified interpretation of (seemingly discrepant) observations on polar and nonpolar glasses. (auth)

20089 CORRELATION OF STRUCTURAL AND CHEMICAL CHANGES IN COTTON CELLULOSE. Razikov, K. Kh.; Tyagai, E. D.; Usmanov, Kh. U. (Scientific-Research Inst. of Chemistry and Tech. of Cotton Cellulose, Tashkent). Acta Chim. Acad. Sci. Hung.; 70: No. 1-2, 155-66(1971). (In Russian).

The structural and chemical changes occurring in cotton cellulose were studied both independently and in correlation with each other. In order to observe the changes in structure, light and electron microscopic methods were used. Structural modifications were effected by treatment of the cellulose with 18% sodium hydroxide solution, isoamyl alcohol, and a mixture of glycerol and water. Examination with a light microscope showed that this treatment produced different changes in the cotton fiber to a varying degree. In some cases the coiled (twisted) structure of the cotton fiber disappeared and its transverse section became almost round. In other cases the twist was retained, but there was a noticeable increase in the mean diameter of the fiber. The electron microscopic observations of ultra-thin cuts confirmed that there were two types of structural changes in the fiber, intrafibrillary and interfibrillary swelling. In other experiments, the cellulose preparations were treated chemically with ethyl cyanide followed by radioinduced graft copolymerization with acrylonitrile. The supermolecular structural features of the cyanoethylated and graft polyacrylonitrile fibers of cotton were established. A relationship was found between the structural and chemical changes of the cellulose samples investigated. (auth)

20090 RADIATION CHEMISTRY OF SATURATED–UNSATURATED HYDROCARBON SYSTEMS. IV. THE EFFECT OF CYCLIC STRUCTURE ON THE RADIATION-CHEMICAL HYDROGEN EVOLUTION FROM HYDROCARBONS WITH 5 TO 8 CARBON ATOMS. Foeldiak, G.; Wojnarovits, L. (Inst. of Isotopes, Budapest). Acta Chim. Acad. Sci. Hung.; 70: No. 1-2, 23-39(1971).

The G_{H_2} values of mixtures of the C_5 through C_8 alkanes (n-pentane, n-hexane, n-heptane, n-octane, cyclopentane, cyclohexane, cycloheptane, cyclooctane) with alkenes of the same carbon atom number (1-pentene, 1-hexene, 1-heptene, 1-octene, cyclopentene, cyclohexene, cycloheptene, cyclooctene), and also the G_{H_2} values of the pure components were determined. The hydrogen evolution yields from the γ radiolysis are strongly affected by the strain due to the ring structure in the cyclic hydrocarbons, and by the individual properties following from the structure of the molecules. When the G_{H_2} values were plotted as a function of the concentration of the unsaturated hydrocarbon, G_{H_2} values of mixtures containing an open-chain saturated hydrocarbon were smaller than the hydrogen evolution yields of saturated–unsaturated hydrocarbon mixtures containing a cyclic alkane. From kinetic calculations the explanation of the observed phenomenon is that, because of the ring strain, the monomolecular processes proceed more rapidly for the cycloalkanes than for the aliphatic alkanes, and so relatively less time is available for the participation of bimolecular processes of "protection." The "protecting effect" toward a given saturated hydrocarbon depends on whether the other constituent is an aliphatic or a cyclic unsaturated hydrocarbon. If the G_{H_2} values measured for the mixtures are plotted as a function of the "double bond concentration," a reasonably common zone is given only in the case when the unsaturated hydrocarbon is an aliphatic one, while a well defined common curve is displayed only for n-alkane–1-alkene mixtures. Conclusions were reached relating to the analogy of intermolecular and intramolecular protecting processes. (auth)

20091 OLEFIN FORMATION IN THE RADIOLYSIS OF n-HEXADECANE. Falconer, W. E.; Sunder, W. A.; Walker, L. G. (Bell Telephone Labs. Inc., Murray Hill, N. J.). Can. J. Chem.; 49: No. 23, 3892-5(1 Dec 1971).

Olefin production in n-hexadecane, γ-irradiated both in liquid and solid states, was estimated by gas chromatography and coulometric titration. Yields of congruent olefin extrapolated to zero dose were G = 1.6 and 2.8 in the solid and liquid, respectively. Total olefin yields at low doses are 2.2 and 4.2 in the solid and liquid. Scission olefin yields are 0.5 and 1.0. Evidence was found for cis as well as trans hexadecene isomers. cis-Olefins can be lost preferentially by exposure to air. (auth)

20092 EFFECT OF ELECTRIC FIELDS ON THE RADIOLYSIS OF ACETYLENE, AND THE MECHANISM OF CUPRENE FORMATION. Briggs, J. P.; Back, R. A. (National Research Council of Canada, Ottawa). Can. J. Chem.; 49: No. 23, 3789-94(1 Dec 1971).

Gaseous acetylene at pressures of about 200 torr was irradiated with γ-rays at doserates between about 10^{11} and 10^{12} eV/cc s,

with and without an electric field applied. The deposition of cuprene on the bottom of the reaction vessel was markedly affected by the field, but the rate of cuprene formation as measured by the pressure decrease was unchanged. Examination of the cuprene deposit with an electron microscope showed it to consist of rather uniform spheres averaging about 3000 Å in diameter, with each containing an estimated 2×10^8 molecules of acetylene. The mechanism of cuprene formation is discussed, and it is suggested that it does not proceed through a direct polymerization of acetylene, but involves a secondary polymerization of polyene intermediates, in the gas phase and after their condensation in liquid droplets. (auth)

20093 UNSTABLE INTERMEDIATES. PART CIV. ELECTRON SPIN RESONANCE STUDIES OF SOLUTIONS OF LITHIUM IN ETHYLAMINE–DIGLYME MIXTURES. Catterall, R.; Hurley, I.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 2, 139-42(1972).

Solutions of lithium in ethylamine are characterized by two ESR features, one, comprising nine hyperfine lines, assigned to coupling with four equivalent nitrogen nuclei, and another, a single narrow line, assigned to solvated electrons. Although no lithium hyperfine coupling was detected, the former unit is thought to be an electron associated with the ion $Li(EtNH_2)_4^+$. Addition of diglyme to such solutions gave an increase in the ^{14}N hyperfine coupling, but no change in the number of hyperfine lines in the concentration range for which the solutions were sufficiently stable for measurement (≤0.56 mol fraction diglyme). In contrast with pure ethylamine solutions, the ^{14}N hyperfine coupling from the diglyme solutions increased on warming. On cooling, clear blue glasses were formed, and the two ESR signals merged into a single broad line with widths between points of maximum slope in the range 14 to 24 G. This is assigned to the solvated electrons, the widths being a measure of the overall hyperfine coupling to ^1H and ^{14}N. Exposure of ethylamine–diglyme glasses to ^{60}Co γ rays gave blue solids which, on bleaching with visible light, lost single ESR lines having widths in the range 15 to 20 G. These units appear to be very similar to those obtained on freezing the lithium solutions. (auth)

20094 OXIDES AND OXYIONS OF THE NON-METALS. PART XV. ELECTRON SPIN RESONANCE SPECTRA OF SOME SELENIUM AND BROMINE RADICALS. Rao, K. V. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 2, 147-50(1972).

Exposure of various crystalline bromates to ^{60}Co γ-rays at 77°K gave radicals identified by their ESR spectra as BrO_2 and BrO_3. Barium sulphate doped with bromate gave BrO_3 together with another bromine-containing radical tentatively identified as BrO_4^{2-}. Frozen aqueous glasses containing bromate ions gave only BrO_2 on irradiation and annealing. Similar treatment of selenates gave the radicals SeO_2^-, SeO_3^-, and SeO_4^-, together with the previously unknown radical SeO_4^{3-}. The latter was formed predominantly when aqueous glasses containing selenate ions were irradiated at 77°K. They were also formed in aqueous selenite glasses. The electronic structures of these radicals are discussed in the light of these results and compared with those for other isoelectronic species. (auth)

20095 CHAIN FORMATION OF ACETALDEHYDE IN THE γ-RADIOLYSIS OF DEAERATED ETHYLENE GLYCOL. Venter, P. J.; van der Linde, H. J.; Basson, R. A. (Atomic Energy Board, Pretoria). J. Chem. Soc., D; No. 3, 187-9(9 Feb 1972).

High yields (G ≤ 200,000) of acetaldehyde were found during an investigation of the γ-radiolysis of pure, deaerated ethylene glycol. (auth)

20096 ELECTRON SPIN RESONANCE OF γ-IRRADIATED COBALT(III) COMPLEXES: ELECTRONIC AND SPIN STATES OF HOT COBALT(II) IONS. Fujiwara, Shizuo; Watanabe, Tokuko; Tadano, Hiroshi (Tokyo Univ.). J. Coord. Chem.; 1: No. 3, 195-205(Feb 1972).

ESR investigation of γ-irradiated Co(III) complexes was carried out. Identification and classification of the irradiation products on the basis of the ESR signal patterns, and the electronic and spin states of the products are discussed. Co(III) complexes are reduced by γ irradiation into Co(II) complexes, where the Co(II) ions produced have low spin configurations, $S = \frac{1}{2}$. These particular spin states are referred to as hot ions. (auth)

20097 PULSE RADIOLYSIS: VERY FAST REACTIONS AND APPLICATIONS TO BIOCHEMISTRY. Land, E. J. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Curr. Top. Radiat. Res. Quart.; 7: No. 2, 105-31(Jan 1972).

Light and high-energy radiations are currently being used to study changes induced by radiation over time scales ranging from 10^{-6} to 10^{-9} sec or less. High-energy radiation studies were made of model systems using nanosecond time resolution. The subjects discussed include: radiation sources and techniques, spurs, dry electrons, electron solvation, and short-lived excited states. Radiation- and photochemical principles are being applied to determine physicochemical properties of biochemical systems. The excited states and excitation transfer properties of various polyene and isoprenoid quinones are considered, and also single-electron transfer reactions of a number of components of the respiratory chain of mitochondria. (auth)

20098 ELECTRON MICROSCOPIC INVESTIGATION OF THE SURFACE AND FIBRILLARY STRUCTURE OF MODIFIED COTTON FIBERS. Usmanov, Kh. U.; Razikov, K. Kh.; Isamukhamedova, I. I. (Scientific-Research Inst. of Chemistry and Tech. of Cotton Cellulose, Tashkent). Acta Chim. Acad. Sci. Hung.; 70: No. 1-2, 143-54(1971). (In Russian).

Results are presented of the electron microscopic examination of the surface and internal structure of cotton fibers modified by radiation-chemical grafting of various vinyl monomers onto the fiber. The monomers are: acrylonitrile (12.5% increase of weight), vinylpyridine (16%), vinylidene chloride (14%), methacrylic acid (60%), and styrene (3.4, 13.4, and 21.5% increases of weight). The structural features of both the surface and the fibrillar portions (secondary walls) of the cotton cellulose were studied as a function of the monomer used for grafting, the increase in weight, and the conditions of the radiation-chemical treatment. The results suggest that the grafting process should be carried out by treatment in the vapor phase. If the cotton fiber has not been treated in order to produce swelling before grafting, graft copolymerization involves mainly the macromolecules on the surface of the cellulose microfibrils, fibrils, etc. If the process is carried out with solutions of the monomers, or by grafting in the gaseous phase, but after preliminary swelling, macromolecules situated in the internal structural elements of the cellulose fiber can take part in the graft copolymerization. (auth)

20099 PROCESS FOR ACCELERATING THE RADIATION INDUCED POLYMERIZATION OF N-VINYLPYRROLIDONE. Marans, Nelson S. (to W. R. Grace and Co.). U. S. Patent 3,630,868. 28 Dec 1971. Filed 23 Apr 1969.

A process was developed for accelerating the rate of radioinduced polymerization of monomeric N-vinylpyrrolidone by mixing about 10 to 90 parts of the N-vinylpyrrolidone with a sufficient quantity of a monomeric acrylamide or acrylic acid to make about 100 parts and irradiating the mixture thus formed. (auth)

20100 RADIATION-CURED SILOXANE-MODIFIED-POLYESTER COATED ARTICLE. Burlant, William J.; Tsou, Ivan H. (to Ford Motor Co.). U. S. Patent 3,632,399. 4 Jan 1972. Filed 17 Oct 1968.

A film-forming, radiation-polymerizable, paint binder solution of vinyl monomers and an alpha-beta olefinically unsaturated, polysiloxane-modified polyester is applied as a liquid coating to an external surface of an article of manufacture and cured thereon with ionizing radiation. The resultant binder resin contains about 0.5 to about 5, preferably about 0.5 to about 3, alpha-beta olefinic unsaturation units per 1,000 units molecular weight. In one embodiment, the binder resin is formed by reacting a siloxane bearing at least two functional groups selected from hydroxy groups and hydrocarbonoxy groups with a polyhydric alcohol and subsequently reacting the siloxane-containing intermediate with a dicarboxylic acid, which provides the resultant polymer with alpha-beta olefinic unsaturation and a second carboxylic acid that provides no additional alpha-beta olefinic unsaturation to the resulting polymer. In a second embodiment, the polyester is formed first by reacting the aforementioned polyhydric alcohol with the aforementioned carboxylic acids and subsequently reacting the resulting polymer with the siloxane. (auth)

20101 FAST CONSECUTIVE INTRAMOLECULAR PROCESSES INVOLVING PROTEIN AND Fe(III) IN FERRI-CYTOCHROME-c IN AQUEOUS SOLUTION. Lichtin, N. N.; Ogdan, J.; Stein, G. (Hebrew Univ., Jerusalem). Israel J. Chem.; 9: No. 5, 579-82(1971).

The reactions of H atoms (produced by nanosecond pulse radiolysis) with ferri-cytochrome-c in aqueous solution result in the second order formation of an absorption spectrum due to the addition of H atoms to the enzyme protein. This spectrum is not specific to the iron moiety. The rate constant of the addition is 1×10^{10} M^{-1} sec^{-1}. This is followed by two first-order intramolecular processes with specific rates of $\sim 1 \times 10^5$ sec^{-1} and $\sim 2 \times 10^4$ sec^{-1}. In these processes, specific spectra related to the α and β bands of ferro-cytochrome-c appear. The results are interpreted to show reduction equivalent transfer through the protein to the iron moiety. (auth)

20102 INVESTIGATION OF THE TIME-TEMPERATURE DEPENDENCE OF STRENGTH AND THERMAL DEGRADATION

OF γ-IRRADIATED COPOLYMER OF STYRENE AND α-METHYLSTYRENE. Muinov, T. M.; Mavlyanov, A. M. (Tadzhik State Univ., Stalinabad, USSR). Vysokomol. Soedin., Ser. A; 13: No. 9, 2059-63(Sep 1971). (In Russian).

The time–temperature dependence of strength and thermal degradation of γ-irradiated (doses 10^6 and 10^7 roentgen) SM copolymer was studied by mass spectrometry. Both initial and irradiated copolymers exhibit "the pole shift effect", with rising radiation dose the pole coordinate $10^3/T_{II}$ increases gradually. Irradiation diminishes the strength of the SM copolymer. Thermal degradation both of irradiated and initial copolymer involves two stages of decomposition. At the first stage decomposition occurs with a lower activation energy, $E_1 = 35 \pm 2$ Kcal/mole, than at the second, $E_2 = 55 \pm 2$ Kcal/mole. Comparison of the activation energies of the mechanical destruction and thermal degradation processes shows that in all cases, both for initial and irradiated SM copolymers, there is good correlation between E_1 and U_{02}. After irradiation the proportion of weak bonds increases somewhat and this leads to poorer strength properties of the polymer. (auth)

20103 FLUORESCENCE SPECTRUM OF THE α-STYRYL RADICAL, $C_6H_5 \cdot C = CH_2$. Brocklehurst, B.; Robinson, J. S.; Tawn, D. N. (Univ. of Sheffield, Eng.). Chem. Phys. Lett.; 12: No. 4, 610-11(15 Jan 1972).

A green thermoluminescence of γ-irradiated glassy solutions of phenylacetylene is ascribed to the fluorescence of the α-styryl radical. (auth)

20104 OBSERVATION OF THE ANTHRACENE EXCIMER DURING NANOSECOND PULSE RADIOLYSIS OF BENZENE SOLUTIONS. Rodgers, M. A. J. (Univ. of Manchester, Eng.). Chem. Phys. Lett.; 12: No. 4, 612-14(15 Jan 1972).

A new absorption band occurring in the near infrared region during pulse radiolysis of solutions of anthracene in benzene is attributed to an electronic transition of the anthracene excimer state. The half-life of the species is <3 nsec. (auth)

20105 PROCESS FOR THE RADIATION GRAFTING OF 4-VINYL PYRIDINE ONTO POLYESTERS IN THE PRESENCE OF A NONPOLYMERIZABLE ORGANIC ACID. Sakurada, Ichiro; Okada, Toshio (to Japan Atomic Energy Research Inst.). U. S. Patent 3,617,457. 2 Nov 1971. Priority date 16 Oct 1967, Japan.

Easily dyeable polyester fibers were prepared by irradiating polyester fibers that had been contacted with a mixture of 4-vinylpyridine and a small amount of a non-polymerizable organic or inorganic acid sufficient to neutralize the 4-vinylpyridine in an aqueous medium to polymerize the 4-vinylpyridine onto the fiber. The ionizing radiation may be corpuscular radiations, such as neutron beams, or electromagnetic radiation, such as gamma radiation or x rays. (Offic. Gaz.)

20106 PHOTOCHEMISTRY OF PROPANE AT HIGH PHOTON ENERGIES (8.4 TO 21.2 eV). Rebbert, R. E.; Lias, S. G.; Ausloos, P. (Inst. for Materials Research, Washington, D. C.). J. Res. Nat. Bur. Stand., 75A: No. 6, 607-12(Nov-Dec 1971).

Neon and helium resonance lamps, which deliver photons of 16.7 to 16.8 eV and 21.2 eV energy, respectively, were used to photolyze C_3H_8, C_3D_8, C_3H_8–C_3D_8 (1 to 1) mixtures, and $CD_3CH_2CD_3$ and the results obtained at the two energies are compared. In particular, it is noted that although the quantum yield of ionization in propane is unity at 16.7 to 16.8 eV, when the energy is raised still further to 21.2 eV, the probability of ionization apparently diminishes to 0.93, an observation which suggests that at 21.2 eV, superexcited states may be reached whose dissociation into neutral fragments competes with ionization. The quantum yields of the lower hydrocarbon products formed in the presence of a radical scavenger in C_3H_8 and C_3D_8 are reported, and are compared with quantum yields of products formed in the vacuum ultraviolet photolysis at lower energies. (Quantum yields of products formed at 8.4 eV and 10.0 eV are reported here for the first time.) Acetylene is formed as a product in the decomposition of the neutral excited propane molecule, and its yield increases in importance with increasing energy; at 16.7 to 16.8 eV, where all product formation can be traced to ionic processes, acetylene is formed in negligible yields. It is concluded that ionic processes in propane do not lead to the formation of acetylene, and the observation of this product in radiolytic systems may be a reliable indicator of the relative importance of neutral excited molecule decomposition processes. From the results obtained with the C_3H_8–C_3D_8 (1 to 1) mixture, and with $CD_3CH_2CD_3$, details of the ion-molecule reaction mechanisms and the unimolecular decomposition of the propane ion are derived. (auth)

20107 VACUUM ULTRAVIOLET PHOTOLYSIS OF CYCLOHEXANONE. Scala, Alfred A.; Ballan, Daniel G. (Worcester Polytechnic Inst., Mass.). Contract AT(30-1)-3945. J. Phys. Chem.; 76: No. 5, 615-20(2 Mar 1972).

In the vacuum ultraviolet photolysis of cyclohexanone, the major modes of decomposition of the electronically excited ketone are as follows: $CO + C_5H_{10}$, A; $CH_2 + CO + 2C_2H_4$, B; $CH_2 + CO + (CH_2)_4$, C; $CO + C_2H_4 + C_3H_6$, D; $H + C_6H_9O$, E; $H_2 + C_6H_8O$, F. The quantum yield for reaction A is 0.68 at 147.0 nm and it becomes less important as the energy of the incident light is increased. Ethylene is the most abundant hydrocarbon product at each wavelength, being produced primarily from reaction B and/or reaction C followed by decomposition of the tetramethylene diradical of two molecules of ethylene ($\phi \simeq 0.2$). Reaction D is unimportant and occurs with a maximum quantum yield of 0.03. Experiments with cyclohexanone-α-d_4 showed that the C_5H_{10} produced in reaction A undergoes secondary decomposition to C_2H_4 and C_3H_6. The remainder of the decomposition of cyclohexanone is accounted for by reactions E and F which become more significant as the energy of the incident light is increased. The mechanisms for reactions A–D are best interpreted in terms of diradicals $(CH_2)_n$ where n = 1, 3, 4, and 5. That nonacyl σ cleavage is unimportant at 147.0 nm indicates that energy absorption occurs primarily at the carbonyl group. Intramolecular hydrogen atom transfer to yield 5-hexenal was not observed. (auth)

20108 EXCHANGE MECHANISM AND ARRHENIUS PARAMETERS OF ELEMENTARY STEPS IN THE REACTIONS OF HYDROGEN ATOMS WITH WATER VAPOR IN IRRADIATED MIXTURES OF HYDROGEN AND WATER VAPOR. Bibler, N. E.; Firestone, R. F. (Ohio State Univ., Columbus). J. Phys. Chem.; 76: No. 5, 621-30(2 Mar 1972).

Efficiencies of the ionizing radiation-induced exchange reactions, $H_2 + D_2O = HD + HOD$ and $H_2 + D_2O = D_2 + H_2O$, were measured at 84 to 381°C. G(HD) is equal to 13.1 ± 0.3 molecules/100 eV and is independent of temperature, under conditions employed, in the range 114 to 150°C. At higher temperatures HD is formed by a chain reaction propagated by $H + D_2O \rightarrow HD + OD$ and $H + D_2O \rightarrow HOD + D$ at comparable rates, and D_2 is formed by $H + D_2O \rightarrow D_2 + OH$ at a much slower rate at 218 to 381°C. Activation energies and relative frequency factors for these elementary steps and for $D + D_2O \rightarrow D_2 + OD$ were evaluated. (auth)

20109 EFFECT OF IONIC DISSOCIATION OF ORGANIC COMPOUNDS ON THEIR RATE OF REACTION WITH HYDRATED ELECTRONS. Peter, Francis A.; Neta, P. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 5, 630-5(2 Mar 1972).

Rate constants for the reactions of hydrated electrons with some organic compounds in γ-irradiated aqueous solutions were measured by competition with p-bromophenol. The yield of bromide ions from p-bromophenol solutions, containing 2-propanol as a scavenger for OH and H, was used as a measure of the reaction of e^-_{aq} with this compound. From the effect of added solutes on $G(Br^-)$ the relative rate constants for the reactions of e^-_{aq} with these solutes were calculated. This method is useful for the determination of $k_{e^-_{aq}}$ in the pH range of 2 to 8. The effect of pH on the rate constants for glycine, aspartic, barbituric, malonic, succinic, and lactic acids was studied. The rate constants for these compounds at their different acid-base states were determined. In all cases the acid form was found to react much more rapidly than the basic form. The rate constant for glycine changes from 9×10^6 M^{-1} sec^{-1} at pH 7.0 up to 2.5×10^9 M^{-1} sec^{-1} at pH 2.1, that for barbituric acid from 9.4×10^7 M^{-1} sec^{-1} at pH 7.6 to 9.3×10^9 M^{-1} sec^{-1} at pH 2.6, and that for malonic acid from 1.2×10^7 M^{-1} sec^{-1} at pH 7.2 to 1.1×10^9 M^{-1} sec^{-1} at pH 2.1. Correlation of structure and reactivity is discussed. (auth)

20110 ELECTRON SPIN RESONANCE STUDY OF TRANSIENT RADICALS IN γ-IRRADIATED ORGANIC INCLUSION COMPOUNDS. II. THE PALMITIC ACID UREA CLATHRATE. Faucitano, A.; Perotti, A.; Allara, G.; Martinotti, F. Faucitano (Univ., Pavia, Italy). J. Phys. Chem.; 76: No. 5, 801-4(2 Mar 1972).

An ESR study of the low-temperature γ radiolysis of the hexadecanoic acid urea adduct is reported. The prominent radical species observed after irradiation at –196°C are the alkyl radical $\sim CH_2\dot{C}HCH_2\sim$ and the radical anion $\sim CH_2\dot{C}(O^-)OH$. The latter decomposes above –78°C yielding the σ-type radical $\sim CH_2\dot{C}=O$, which decays, at room temperature, with a half-time of 10 to 15 min, yielding finally the radical $\sim CH_2\dot{C}HCOOH$. Reaction mechanisms are proposed. (auth)

20111 PREIRRADIATION GRAFTING TO WOOL AND CELLULOSIC FIBERS. Williams, Joel Lawson. Raleigh, N. C.; North Carolina State Univ. (1971). 164p. University Microfilms order No. 71-29,438.

Thesis.

Details of the preirradiation grafting of vinyl monomers to wool and cellulosic fibers have been investigated. Special emphasis has been given to ethyl acrylate, which polymerizes to yield a

soft polymer. It has been found that very high yields of grafting can be obtained when using aqueous monomer suspensions employing the preirradiation technique. The grafting curves obtained do not resemble the normal leveling of grafting with time as usually found with the preirradiation method. Instead, the grafting starts at a slow rate and later changes to second greatly increased rate of grafting. Examination of fiber properties above and below the rough transition point in the corresponding grafting curve indicates that very highly rubber-like elastic properties are obtained above this point. Below this transition, the fiber properties are not markedly changed from those of the parent substrate. Grafting levels required for high elasticity were generally around 1000% without further modification. When grafting of ethyl acrylate was carried out in the presence of a comonomer, intermediate grafting rates were obtained depending on the size and reactivity of the comonomer. However, when the comonomer was also difunctional and soluble in the organic phase fast rates of polymerization were encountered with most of the monomer being consumed in homopolymerization. On the other hand, if the difunctional monomer was water soluble little or no homopolymerization was observed and the highly grafted fibers had better recovery properties than in the absence of such cross-linking monomers. The rates of the grafting reaction were considerably improved between 25°C and 35°C. Polymerization at higher temperatures did not result in greatly increased rates due to competing homopolymerization above circa 60°C. Also, the grafting reaction was not sensitive to the ionic nature of the emulsifier used for monomer dispersion. Under certain swelling conditions it was found that truly spontaneous grafting could be achieved to the various substrates investigated. In this case the grafting reaction is initiated by the anisotropic swelling of the fiber which results in a few broken tie molecules. As the grafting reaction proceeds the anisotropic swelling becomes more pronounced, the gel effect begins to restrict termination, and finally a high grafting rate is observed. Again, high elasticity was observed at the high grafting levels. Several pretreatments of the fiber substrate were carried out prior to grafting. These various treatments did not result in any vast differences in the grafting reaction of the subsequent fiber properties. Examination of grafted samples by electron microscopy revealed that elasticity was obtained when the grafting had occurred all the way to the innermost depths of the fiber. Electron micrographs indicated that the grafted fiber had an expanded morphology which was able to extend more freely restrained only by the presence of residual crystalline regions that serve as cross-links. Of the various methods of grafting examined, the preirradiation technique yielded by far the best results with a minimal amount of homopolymerization. (Diss. Abstr. Int., B)

20112 ELECTRON SPIN RESONANCE STUDIES OF RADICAL PAIRS IN CARBAZIDE AND OF NUCLEOSIDE BASE RADICALS IN 5-CHLOROURIDINE. Reiss, Keith Wescott. Durham, N. C.; Duke Univ. (1971). 159p. University Microfilms Order No. 72-332.

Thesis.

The ESR of carbazide ($NH_2NHCONHNH_2$) after γ-irradiation at 77°K exhibits signals corresponding to an effective g-value of 4, in addition to the usual free radical signals corresponding to g = 2. These half-field lines (also observed in N-methyl-hydroxylamine hydrochloride, acetamide, oxamic acid, and glutaric acid) correspond to second order transitions ($\Delta M_s = \pm 2$) of a spin triplet state formed by the coupling of two neighboring radicals. Measurements of the g = 2 spectra allowed resolution of the dipolar coupling tensor giving principal values $D_{||} = 665.0$G and $D_{\perp} = -332.5$G, thus confirming the cause of the g = 4 line to be radicals bound in pairs via the electron exchange interaction. There are two magnetically inequivalent pair species present, which are chemically the same but different in relative orientation. The intrapair average spin separation was deduced from the observed D-values to be R = 4.374 Å for both pairs. Vectors describing the spin separation of each pair were found to be 29.883° apart. An analysis of the temperature dependence of the radical pair half life by isothermal annealing gave the activation energy $E_a = 0.165$ ev. The isolated radical population, which consists of several chemical species, is also thermally unstable and undergoes several distinct changes at temperatures greater than 77°K. The ESR spectrum of a γ-irradiated single crystal of 5-chlorouridine shows a very strong, broad and symmetric component with g-value ranging from approximately 2.2 to 3.1. Because of its form and especially because of the large asymmetric g-value it is concluded that this resonance arises from spin density on Cl, probably on trapped or semi-bonded Cl atoms. Another component, orders of magnitude weaker, with a g-value of 2.0059 and with an orientation-dependent hyperfine structure was also observed. Detailed measurements and analyses of this second resonance indicate that it arises from an H-addition uridine radical. This requires that the Cl atoms of the base ring are replaced by H atoms to form uridine which then undergoes a further H-addition to produce the observed radical. The source of the H atoms is not definitely known, but they are probably released from the ribose component by the irradiation. (Diss. Abstr. Int., B)

20113 THERMOLUMINESCENCE INTENSITY AS A FUNCTION OF RADIATION DOSE. Butterfield, A. W. (Defence Standards Labs., Melbourne). Mol. Cryst. Liquid Cyrst.; 16: No. 1-2, 185-7(Feb 1972).

The thermoluminescence of organic crystalline materials is found in several instances to show an initially-linear increase with radiation dose; after a certain irradiation time no further increase in tensity is observed and the form of the glow is independent of dose. (auth)

20114 ELECTRON SPIN RESONANCE STUDY OF RADICALS PRODUCED IN IRRADIATED AQUEOUS SOLUTIONS OF URACIL AND RELATED PYRIMIDINES. Neta, P. (Carnegie-Mellon Univ., Pittsburgh). Radiat. Res.; 49: No. 1, 1-25(Jan 1972).

Radicals produced in irradiated aqueous solutions of uracil, orotic and isoorotic acid, barbituric acid, thymine, and 6-methyluracil were studied using the in situ radiolysis steady-state ESR method. For each compound different spectra were observed at the different pH values examined. The reaction of OH radicals with the pyrimidine bases was found to take place through addition of the OH to either position 5 or 6 and in most compounds studied both possibilities were observed. Radicals formed by addition of OH to position 5 were found to undergo enolization between C_5 and C_4 followed by dissociation. Radicals formed by addition of OH to position 6 were found in most cases to undergo rapid ring opening between C_6 and N_1. The spectra of all the radicals observed changed considerably with pH because of acid-base dissociations. In the case of thymine and 6-methyluracil it was found that at high pH O^- can abstract hydrogen from the methyl group to form an allyl-type radical. Radicals produced by the reaction of e^-_{aq} with pyrimidine bases were observed in the case of orotic and isoorotic acid. (auth)

20115 TRANSIENT RADICALS OF DNA BASES BY PULSE RADIOLYSIS. EFFECTS OF CYSTEINE AND CYSTEAMINE AS RADIOPROTECTORS. Nucifora, G. (Laboratorio di Fotochimica e Radiazioni d'Alta Energia, Bologna); Smaller, B.; Remko, R.; Avery, E. C. Radiat. Res.; 49: No. 1, 96-111(Jan 1972).

Transient radicals of nucleic acid components formed by e^-_{aq} and OH reaction during pulse radiolysis were observed using the electron paramagnetic resonance (EPR) technique. The effect of cysteamine and cysteine on the decay properties of the radical was investigated. For the natural bases, the predominant mechanism of protection seems to be a competition reaction for the OH rather than a hydrogen transfer from the thiol to the organic radical; however, hydrogen transfer does occur for dihydrothymine. Rate constants are given for these reactions and for reactions with OH and O_2. (auth)

20116 KINETICS OF RADICAL DECAY IN CRYSTALLINE AMINO ACIDS. Stentz, Frankie B.; Taylor, E. D.; Johnsen, Russell H. (Florida State Univ., Tallahasee). Contract AT(40-1)-2001. Radiat. Res.; 49: No. 1, 124-32(Jan 1972). (ORO-2001-16).

The disappearance of free radicals in irradiated polycrystalline and single-crystal amino acids was studied by ESR at 23°C. The decay appears to be second order in radical concentration and the rate is consistent with a vacancy-controlled bulk diffusion process. The acids studied include DL and L-leucine in polycrystalline and single crystalline forms, as well as DL-valine in polycrystalline form. L-Valine and L-isoleucine were studied in both poly and single crystalline form. The second order decay constants ranged from 3.9×10^{-21} to 2.2×10^{-14} grams spins^{-1} minutes^{-1}. (auth)

20117 RADIATION-CONVERTIBLE POLYMERS. (to Union Carbide Corp.). British Patent 1,263,294. 9 Feb 1972. Priority date 15 Jan 1968, United States.

Crosslinking polymers containing the norbornenyl group as the crosslinking site by using radiation initiation are described. These polymers are very susceptible to radioinduced curing, have high oxidative stability, and both ionizing and nonionizing radiation can be used for crosslinking. Eleven examples are given. (M.C.G.)

20118 MECHANISM OF TRIPLET MOLECULE FORMATION IN SOLID SOLUTIONS UPON X-RAY EXCITATION. Lisovskaya, I. A.; Alfimov, M. V. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 2, 107-9(Aug 1971).

Translated from Opt. Spektrosk.; 31: No. 2, 200-4(Aug 1971).

The mechanism of the formation of triplet molecules in organic glasses is investigated by x-ray luminescence. From a study of the dependence of the x-ray fluorescence and phosphorescence of

naphthalene-d_8 on its concentration in solution and on the concentration of octene-1, it is shown that the basic mechanism for the formation of triplet and singlet molecules of naphthalene-d_8 is the transfer to the additive of the corresponding energy from the triplet and singlet excited states of toluene. The triplet states of toluene are formed from singlets as a result of singlet–triplet conversion. The x-ray luminescence spectra of solid solutions of naphthalene-d_8 in methylcyclohexane is explained by assuming the transfer of singlet excitations and charges from the matrix to the additive. (auth)

20119 PROCEEDINGS OF THE FOURTH INTERNATIONAL WOOL TEXTILE RESEARCH CONFERENCE. PART I. Conference Held at Berkeley, California, August 18–27, 1970. Rebenfeld, Ludwig (ed.). Appl. Polym. Symp.; No. 18, 1-742 (1971). (CONF-700850-(Pt.1)).

Seventy-two papers presented at the conference are included. Separate abstracts were prepared for 2 papers. (M.C.G.)

For abstracts of individual papers see: 20120 and 20121.

20120 FREE RADICALS INDUCED IN WOOL BY X-RAYS. Eaton, W. C.; Keighley, J. H. (Univ. of Leeds, Eng.). Appl. Polym. Symp.; No. 18, 263-8(1971).

From fourth international wool textile research conference; Berkeley, Calif. (18 Aug 1970).

ESR studies on free radicals induced in wool by x rays are reported. Glycine, alanine, and cystine radicals were identified at room temperature and compared with studies at 77°K. (M.C.G.)

20121 GRAFT COPOLYMERIZATION ONTO WOOL FIBERS BY FREE RADICAL INITIATORS. Arai, Kozo; Negishi, Michiharu; Komine, Shigeo; Takeda, Kiyoshi (Gunma Univ., Japan). Appl. Polym. Symp.; No. 18, 545-57(1971).

The nature of the termination mechanism and the grafting center during graft copolymerization of methyl methacrylate on wool and silk fibroin fibers in the presence of various initiators was investigated. From kinetic considerations it was concluded that in wool, internally deposited polymers were truly grafted on cysteine residues and that the occurrences of termination by disproportionation between graft-polymer radicals begin to increase sharply at a transition temperature. Termination is controlled by the stability of chain segments of the backbone polymer. In the case of methanol–benzoyl peroxide systems, it was suggested that the tyrosine residue plays an important role as an active center for grafting. Glycyl residue groups may be incorporated into isolated polymers from the graft copolymer of silk fibroin fibers prepared by the ^{60}Co γ mutual irradiation method. (auth)

20122 POLYMER STABILIZATION. Hawkins, W. Lincoln (ed.). New York; John Wiley and Sons, Inc. (1972). 458p. $24.95.

A mechanistic approach is presented to the problems of polymer stabilization in order to protect against all major environmental factors responsible for deterioration. The first chapter covers general reactions of polymer degradation, each of the following eight chapters is concerned with stabilization against a particular type of degradation, and the final chapter presents a critique of methods used to evaluate polymer stability. A separate abstract was prepared for one chapter. (D.H.M.)

For abstract of individual chapter see: 20123.

20123 PROTECTION AGAINST IONIZING RADIATION. Lyons, B. J.; Lanza, V. L. (Raychem Corp., Menlo Park, Calif.). pp 249-311 of Polymer Stabilization. /Hawkins, W. Lincoln (ed.). New York; John Wiley and Sons, Inc. (1972).

A review is presented of radiation protection of polymers that is confined to synthetic polymers and biological polymers when studied in vitro. The areas considered include kinetics of scavenging; methods of estimating scavenging; and experimental results for internal protection, external protection against crosslinking, external protection against degradation, and protection in polymer solutions. (D.H.M.)

20124 RADIOLYTIC OXIDATION OF MALACHITE GREEN LEUCOBASE IN ACETONE SOLUTION. Dejehet, F. G.; Coget, F. G.; Apers, D. J.; Capron, P. C. (Univ., Louvain, Belg.). Radiochem. Radioanal. Lett.; 9: No. 2, 93-103(30 Jan 1972).

On exposure to γ rays, the leuco base of Malachite Green in acetone undergoes oxidation into the corresponding dye. The system may be used as a dosimeter in the region of 3 to 15 Krads, although the response to dose is not linear. (auth)

20125 FORMATION OF IODIDES IN SOLID BUTANE IRRADIATED BY I^+ IONS. Cailleret, J.; Abbe, J. Ch.; Paulus, J. M. (Centre de Recherches Nucleaires, Strasbourg). Radiochem. Radioanal. Lett.; 9: No. 2, 113-18(30 Jan 1972). (In French).

Previous experiments performed with a chemical accelerator in order to study the formation of organic iodides in solid butane bombarded with I^+ ions were extended to low energy ions (<50 eV). The total organic yield decreases in the energy range from 3000 eV to 50 eV but increases when the energy is further reduced; the distribution of the iodides formed is strongly energy dependent. (auth)

20126 POLYMERIZATION OF METHACRYLOYL CHLORIDE. Usmanov, Kh. U.; Nadzhimutdinov, Sh.; Khalikov, T. Vysokomol. Soedin., Ser. B; 13: No. 11, 827-9(Nov 1971). (In Russian).

Methacryloyl chloride readily polymerizes under the influence of γ radiation or during heating in the presence of dissolved initiators: azoisobutyric acid dinitrile or benzoyl peroxide. The Cl content of the resulting polymethacryloyl is less than anticipated. The infrared spectrum of the polymer is discussed. (K.S.W.)

20127 RELATIONSHIP BETWEEN THE PHYSICOCHEMICAL PROPERTIES OF ORGANIC COMPOUNDS AND THEIR ANTITUMOR EFFECTIVENESS. Izmozherov, N. A. Izv. Estestvennonauch. Inst. Perm. Gos. Univ.; 14: No. 10, 113-16(1970). (In Russian).

Simulated experiments using the electron paramagnetic resonance method showed that when cystaphos, thiourea, histamine, serine, cysteine, methionine, asparagine, arginine, biotin, norvaline, or norleucine is paired with electron acceptors (riboflavin, chloranil), some of these substances are capable of forming charge transfer complexes, an indication that they have donor properties. Radioprotectors (Rp) proved to be electron donors. Experiments with water irradiated with ^{60}Co gamma rays and with substances presumed to be Rp showed that these substances possess donor activity. These findings may be useful for rapid screening of Rp and directed synthesis thereof. (JPRS)

20128 EFFECT OF CHAIN TRANSFER AGENTS ON THE GAMMA-INDUCED POST-POLYMERIZATION OF TRIOXANE IN THE SOLID STATE. Sakamoto, Masahiro (Japan Atomic Energy Research Inst., Takasaki); Shimizu, Akira; Ito, Akihiko; Hayashi, Koichiro. Kobunshi Kagaku; 28: No. 10, 779-84(Oct 1971). (In Japanese).

In the presence of acetic anhydride or methylal, the yield and molecular weight of the polymers obtained by the γ-induced post-polymerization of trioxane in the solid state decreased with the increase in the content of these additives and, at the same time, the thermal stability of the polymer was improved. The results are understandable in terms of capping of the polymer chain ends with acetyl or methoxy groups due to chain transfer with the additives. Percentage of the stable polymer was calculated from the value of apparent chain transfer constant, k_{tr}, obtained by kinetic calculations and compared with observed values. (auth) (Japan)

20129 STRUCTURAL PECULIARITIES OF BUTADIENE–STYRENE RUBBERS BY A RADIOTHERMOLUMINESCENCE METHOD. Masagutova, L. V.; Zlatkevich, L. Yu.; Guseva, V. I.; Nikol'skii, V. G. Vysokomol. Soedin., Ser. B; 13: No. 12, 881-3(Dec 1971). (In Russian).

The structural features of a series of butadiene–styrene elastomers were analyzed by a radiothermoluminescent technique: recording the light emitted from heating solid organic materials that had previously been irradiated at low temperatures with electrons or γ rays. The vitrification temperatures of these copolymers were found to be dependent on their molecular structures; some samples possessed a much wider temperature interval of vitrification than others. (K.S.W.)

20130 RADIOCHEMICAL GRAFTING OF ACENAPHTHYLENE TO POLYETHYLENE. Zagorskaya, E. G.; Tukhomirova, N. S.; Serenkov, V. I. Vysokomol. Soedin., Ser. B; 13: No. 9, 688-92(Sep 1971). (In Russian).

The kinetics and mechanism of radiochemical grafting of acenaphthylene to polyethylene were studied. Polyethylene film and a solution of acenephthylene in acetone–water were irradiated with ^{60}Co γ radiation in order to obtain the grafted copolymer. In the dose range of 1 to 6 MRad, it was evident that the process was controlled by the diffusion rate of the monomer and also inhibited by formation of acenaphthylene homopolymer. Yields of the grafted copolymer were increased by periodically washing the film. (K.S.W.)

20131 RADIATION-INDUCED EMULSION POLYMERIZATION OF VINYL CHLORIDE. Smirnov, A. M.; Lukhovitskii, V. I.; Pozdeeva, R. M.; Karpov, V. L. Vysokomol. Soedin., Ser. B; 13: No. 10, 747-50(Oct 1971). (In Russian).

The process of radioinduced emulsion polymerization of vinyl chloride with ^{60}Co γ radiation in the presence of anionogenic emulsifiers was investigated. The yield of polymer was measured at 25°C gravimetrically as a function of the radiation time. The polymerization rate was determined as a function of dose intensity and of the concentration of the original emulsion. The character-

istics of the radioinduced process correspond to those of the chemically induced emulsion polymerization, but not to the theory of W. Smith and R. Ewart. (K.S.W.)

20132 RADIOTHERMOLUMINESCENCE OF BUTADIENE–STYRENE AND BUTADIENE–METHYLSTYRENE ELASTOMERS. Zlatkevich, L. Yu.; Nikol'skii, V. G. (Inst. of Chemical Physics, Moscow). Vysokomol. Soedin., Ser. B; 13: No. 11, 810-12(Nov 1971). (In Russian).

A number of industrial elastomers and purified samples (freed of stabilizers, emulsifiers, etc.) were extracted with 1:1 acetone–ethyl alcohol for 48 hr and then irradiated at 77°C in a vacuum by ^{60}Co gamma radiation. The dependence of intensity of thermoluminescence of the irradiated samples on the temperature from 100 to 220°K was noted. Extraction of impurities improved the resolution of the maxima of thermoluminescence. (K.S.W.)

20133 INFLUENCE OF TEMPERATURE ON THE γ-RADIOLYSIS OF LIQUID n-PROPANOL. Afanas'ev, A. M.; Kalyazin, E. P. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 6, 731-4(Nov-Dec 1971). (In Russian).

The temperature dependence of radiolysis of n-propanol by an absorbed dose of ^{60}Co gamma radiation (8.9×10^{19} eV/g) was investigated over the temperature range (approximately) −80 to +230°C. The following products of radiolysis were quantitatively determined: CO_2, propane, methane, propylene, ethylene, ethyl propyl ether, dipropyl ether, hydrogen, propionaldehyde, 3,4-hexanediol, 1,2-butanediol, propyl formate, formaldehyde, ethylene glycol, ethane, and methanol. The data indicate that a chain mechanism occurs at the higher temperatures. (K.S.W.)

20134 RADIATION-INDUCED IONIC POLYMERIZATION CONTROLLED BY THE PRESENCE OF LEWIS ACIDS OR LEWIS BASES. Williams, Thomas F. (to United States Atomic Energy Commission). U. S. Patent 3,616,369. 26 Oct 1971. Filed 9 Nov 1967.

A method for controlling the molecular weight of a polymer derived from an ethylenically unsaturated monomer, which can be catalyzed to polymerize by a Lewis acid, comprises mixing the monomer with a Lewis base soluble in the monomer and then reacting the mixture with an amount of high-energy radiation at least sufficient to initiate and propagate polymerization of the monomer. The Lewis base is selected from the class that functions to determine the molecular weight of the polymer produced at a given radiation dosage and temperature, and the monomer is selected from an ethylenically unsaturated monomer having electron-releasing groups attached directly or indirectly to the ethylenic linkage of the monomer, which impart a Lewis base character to the monomer. This method is also applicable to controlling the molecular weight of a polymer derived from a monomer that can be catalyzed by a Lewis base. In that case, the molecular weight of the final polymer can be controlled by mixing the monomer with a Lewis acid and then irradiating the mixture at a given temperature and to a given radiation dosage. (Offic. Gaz.)

20135 REACTIVITY OF SOLVATED ELECTRONS IN RADIOLYZED CYCLOHEXANE, CYCLOHEXANE–2-PROPANOL AND METHANOL–WATER. Matsuoka, Haruko; Sato, Kuniyoshi; Asahi, Yoshimi; Masuda, Takahiro; Kondo, Masaharu (Tokyo Metropolitan Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 7-10(Jan 1972).

Hammett's reaction constants for the reactions of solvated electrons with substituted chlorobenzene series are 0.7 and 2.5 in cyclohexane–2-propanol and methanol–water systems respectively. The simple relation observed in alcoholic solvents between Hammett's reaction constants and the dielectric constant fails to apply to the present systems. These findings can be semiquantitatively explained as being a result of the closer correlation presented by Hammett's reaction constants to the transition energy for the optical excitation of solvated electrons rather than to the dielectric constants of the medium. (auth)

20136 CHANGES IN THE OXIDIZABILITY OF AQUEOUS SOLUTIONS OF SOME ORGANIC MATERIALS DUE TO THE ACTION OF RADIATION. Tsutsarin, V. V.; Byalkovskii, N. N.; Yatsun, V. V.; Zhikharev, V. S.; Vysotskaya, N. A. (Inst. of Physical Chemistry, Kiev). Khim. Tekhnol.; No. 3, 12-15(May-Jun 1971). (In Russian).

Oxidizability characterizes total content of the reducing agents in water. It is expressed by the amount of oxygen needed for the oxidation of organic material contained in a 1:1 solution of CO_2 in water. Changes of this oxidizability in waste waters of the Kiev Chemical-Pharmaceutical Plant taking place upon γ irradiation with a ^{60}Co source were studied. These waters contain about 30 inorganic impurities and 70 of the organic nature. In addition, model systems containing methanol, isopropyl alcohol, phenol, methacrylic acid, and their mixtures were investigated. Irradiation was found to lower the oxidizability, leading occasionally to formation of precipitates. The model system showed more pronounced lowering of the oxidizability than natural waste waters, because the latter most probably contained many admixtures capable of oxygen consumption. (JPRS)

20137 DIELECTRIC LOSSES IN TRIGLYCINE SULFATE CRYSTALS SUBJECTED TO VARIOUS EFFECTS. Burdanina, N. A.; Zolototrubov, Yu. S.; Kamysheva, L. N.; Zhukov, O. K.; Kovalenko, A. N. (Voronezh State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 9, 1943-6(Sep 1971). (In Russian).

The influence of gamma and x radiation has been studied previously as it concerns the ferroelectric properties of a triglycine sulfate crystal (TGS). Since the parameter most sensitive to radiation is the tangent of the angle of dielectric losses, tan δ, it can be expected that even small radiation doses will significantly change both the value of tan δ and the function tan δ (T) for the TGS. In this work the effect of the amplitude of the measuring field on these same functions was studied. The effects of annealing on the dielectric properties were studied, and it was found that orientation polarization makes a significant contribution to the dielectric permeability of the TGS as a result of heat annealing. Studies were then made on effects of the amplitude of the measuring field on samples having different thicknesses, indicating a relation to characteristics of the domain structure. Preliminary investigations confirm that the degree of unipolarity in the samples increases as their thickness decreases. Studies on effects of irradiation on the dielectric properties indicated that there is a decrease in the dielectric losses in the TGS crystal irradiated with comparatively small radiation doses. (JPRS)

Radiochemistry and Nuclear Chemistry

20138 SYNTHESIS OF LABELED o-IODOHIPPURIC ACID. Wheeler, O. H.; Verter, H. S.; Feliu, L. A.; de Jesus, C. R. (Puerto Rico Nuclear Center, Mayaguez). J. Label. Compounds; 7: No. 1, 40-5(1971).

The reaction of o-iodohippuric acid with labeled iodide was shown to afford exclusively labeled o-iodohippuric acid. The same compound was synthesized from anthranilic acid. The rate of exchange was sufficiently rapid to permit the preparation of ^{132}I and ^{128}I labeled o-iodohippuric acid. The mechanism of the exchange is discussed. (auth)

20139 MODERN TRENDS IN NUCLEAR CHEMISTRY. Gol'danskii, V. I. Fiz. Szemle; 21: No. 11, 329-37(Nov. 1971). (In Hungarian).

Since the establishment of the Laboratory for Nuclear and Radiation Chemistry of the USSR Academy of Sciences 10 years ago, the attention of the researchers has been focused on the study of chemical reactions by means of methods of nuclear physics, in order to clarify the structure of compounds and to obtain additional information about reaction mechanisms. The fields covered included the multiple polarization of excited and "hot" atoms and molecules, lattice defects, and the effect of local annealing. Within the framework of "hot" atom chemistry, the formation of excited radicals and their reactions were studied through tritium experiments; studies with ^{35}S resulted in the development of a hot synthesis of S-containing compounds of special interest in biomedical applications. ^{35}S is formed by the ^{35}Cl(n,p)^{35}S reaction; at the moment of their formation, the ^{35}S atoms may reach an energy of up to 16.5 keV, slowing down as they collide with the surrounding atoms and molecules. They are thus able to replace the nonradioactive S and even to penetrate into hydrocarbon chains. Studies have been also carried out on condensed-phase transitions of matter along the tracks of highly ionizing nuclear particles in locally overheated areas. Study of the fixation of nitrogen in the form of NO_2, NH_4 radical, NH_2-NH_2, and HCN in gas phases, such as $N_2 + O_2$ and $N_2 + CH_4$, revealed that the radiation chemical yield attributable to heavy ions does not exceed that caused by the action of protons, electrons, and γ radiation. (Review article). (TTT)

20140 PREPARATION OF RADIOACTIVE GOLD COLLOIDS FOR INDIRECT ISOTOPE LYMPHOGRAPHY AND ITS ONCOLOGICAL APPLICATION. Csetenyi, J.; Fuezy, M.; Karika, Zs. (Postgraduate Medical Inst., Budapest). Isotopenpraxis; 7: No. 9, 366-9(Sep 1971).

Radioactive colloidal gold suitable for indirect isotope lymphography reduced by glucose was prepared. PVP and gelatin were used as stabilizers. The particle size distribution was checked by electron microscope and the size distribution of particles was found nearly identical. For the examinations of ab-

sorption from the subcutaneous tissues of hand and foot, the gelatin as a protective colloid proved to be better. (auth)

Hot-Atom Chemistry

Refer also to abstract 20096.

20141 INFLUENCE OF ROTATIONAL CONFORMATION ON THE STEREOCHEMICAL COURSE OF HOT HALOGEN FOR HALOGEN SUBSTITUTION IN LIQUID 2,3-DICHLOROBUTANE. Vasaros, L.; Machulla, H.-J.; Stoecklin, G. (Kernforschungsanlage, Juelich, Ger.). J. Phys. Chem.; 76: No. 4, 501-7(17 Feb 1972).

The mechanistically important question of retention vs inversion of configuration in hot halogen for halogen replacement at asymmetric carbon atoms was reinvestigated in the light of conformational analysis. Substitution of chlorine in liquid 2,3-dichlorobutane by recoil halogen can lead to both retention and inversion, depending on the conformation of the molecule and the mode of impact. The observed conformational effect provides evidence that true hot replacement reactions in the liquid phase can also proceed with inversion of configuration. The possible contribution from thermal cage combination processes to the product formation is also discussed. (auth)

20142 REACTIONS OF RECOIL ^{32}P ATOMS WITH PF_3 AND PH_3. Stewart, G. W.; Hower, C. O. (Univ. of Idaho, Moscow). J. Inorg. Nucl. Chem.; 34: No. 1, 39-45(Jan 1972).

The chemical behavior of recoil ^{32}P atoms in PH_3 and PF_3 was studied in order to determine the general feasibility of extending hot atom investigations to phosphorus. Recoil phosphorus was generated by the $^{31}P(n,\gamma)^{32}P$ reaction. $^{32}PH_3$ and $^{32}PF_3$ were the only volatile products observed in phosphorus atom reactions with PH_3 and PF_3. $^{32}PH_3$ was observed as a reaction product with H_2. An upper limit of 0.1% was established for primary retention in PF_3. Scavenger studies were performed on PF_3 and a moderator study was made on a PH_3-PF_3 mixture. 60% of the $^{32}PH_3$ yield appears to result from hot phosphorus atoms and 40% from thermal atoms. A plausible reaction mechanism for the production of $^{32}PH_3$ and $^{32}PF_3$ is discussed. (auth)

20143 CHEMICAL EFFECTS OF THE $^{31}P(n,\gamma)^{32}P$ REACTION BELOW 20°K. Kobayashi, Mitsue; Takada, Jitsuya; Kitaoka, Yoshinori; Kiso, Yoshiyuki. Annu. Rep. Res. Reactor Inst., Kyoto Univ.; 4: 140-3(1971).

Chemical effects of the $^{31}P(n,\gamma)^{32}P$ reaction in phenylphosphorus compounds were studied in a low-temperature irradiation facility. A method is shown for chemical separation of recoil products. It is shown that the P–C bond formation of phosphorus atoms or phosphorus radicals with phenyl groups occurs in a hot reaction at high energy, but P–OH bond formation occurs even at thermalized stages as well as in the hot region. (M.C.G.)

Properties of Radioactive Materials

Refer also to abstracts 20313 and 20553.

20144 (CEA-R-4200) HETEROGENEOUS KINETICS OF THE REACTION INTERFACE IN THE FLUORINATION OF MONOCRYSTALLINE UO_2. Idrissi, Rachid (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1971. 125p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France). Faculte des Sciences.

The reactive interface occurring in the fluorination of monocrystalline uranium oxide was studied from the point of view of heterogeneous kinetic chemistry. The following points were studied: the establishment of the existence of this interface, the determination of its physicochemical nature, the determination of the precise role it plays in elementary chemical processes, and the search for a kinetic model taking into account both the results obtained here and other published results. The two dimensional chemical structures $UO_2(111)$; $C(2\times2)$, $(UO_2)_6F$; $(UO_2)_6F$; $(UO_2)_4F$; $(UO_2)_3F$; $(UO_2)_2F$; and UO_2F, are among the intermediate new phases discovered. (auth)

20145 (K-Trans-62) SOLUBILITY OF ^{85}Kr IN SOME ORGANIC SOLVENTS. Yamamoto, Yutaka; Takeda, Hiroshi. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from Tokyo Daigaku Kogakubu Kiyo, A; No. 7, 44-5(1969). 5p. Dep. NTIS.

Radioactive isotopes of noble gases such as Kr and Xe must be removed from off-gas streams during reactor emergencies and normal large-scale fuel reprocessing operations. Among the noble gas removal processes known, selective absorption of noble gases in some organic solvents has the advantage of concentrating noble gases to high levels in a continuous process despite its disadvantages of radiation damage to the solvents and relatively high percentage loss of solvents. Three kinds of solvents, i.e., carbon tetrachloride, kerosene, and freon 12 were chosen in view of their cohesive energy density values. Since Xe is more soluble than Kr, Ostwald absorption coefficient values of ^{85}Kr from dilute $Kr-N_2-O_2$ gas mixture systems were measured. These experimental data can be correlated by modified Prausnilz's equation based on the Hildebrand's regular solution theory. (auth)

20146 (NIM-1380) ELECTROCHEMICAL MODEL FOR THE LEACHING OF URANIUM DIOXIDE. Needes, C. R. S.; Nicol, M. J. (National Inst. for Metallurgy, Johannesburg (South Africa)). 10 Jan 1972. 32p. Dep. NTIS (U. S. Sales Only).

A correlation between the rate of leaching of UO_2 and the electrochemical properties of the oxidant concerned was derived. This correlation is borne out by experimental results. Certain effects observed in UO_2 leaching and hitherto unexplained were clarified in terms of an electrochemical mechanism. Experiments showed that the mixed potential of a UO_2 electrode gives a measure of the rate of dissolution of UO_2. Its significance to commercial practice is discussed. (auth)

20147 (TID-7518(Pt.2)) INDUSTRIAL TECHNICAL INFORMATION MEETING ON COLD PROCESSING OF ENRICHED URANIUM, OAK RIDGE, SEPTEMBER 13–15, 1956. (Oak Ridge Operations Office (AEC), Tenn.). Sep 1956. 460p. Dep. NTIS. Declassified 26 Oct 1971.

20148 HYDROXIDE METATHESIS OF MULTIGRAM AMOUNTS OF CURIUM OXALATE. Bibler, N. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Inorg. Nucl. Chem. Lett.; 8: No. 2, 153-6(Feb 1972).

A rapid and simple method for purifying and concentrating large amounts of Cm by oxalate precipitation is described, followed by an oxalate-hydroxide metathesis procedure, giving the advantages of the fast filtration properties of the oxalate and the dilute solubility of the hydroxide. In contradistinction to previously used hydroxide metathesis procedures the process described occurs at room temperature in less than one hour. Both NaOH and KOH were evaluated as metathesizing agents, and preliminary studies were made with Sm as stand-in for ^{244}Cm. Precipitate working was more efficient with KOH than NaOH since $K_2C_2O_4$ is about seven times more soluble than $Na_2C_2O_4$. In experiments with 2M KOH it was found that only 0.5M excess OH^- is required for complete metathesis and reaction is complete in about 15 mins at 25°C. The results were confirmed by studies with ^{244}Cm. Results for a large scale application of the process are given, showing a Cm recovery of 99.93%. The process was successfully applied to recovery of Cm from large volumes of solutions that were 1 to 2M in Fe and Al. In general, separations from impurities were not obtained during the hydroxide metathesis step, presumably due to the absorptive properties of hydroxide precipitates. (UK)

20149 DISTRIBUTION OF LANTHANIDE AND ACTINIDE ELEMENTS BETWEEN LIQUID BISMUTH AND MOLTEN LiCl–LiF AND LiBr–LiF SOLUTIONS. Ferris, L. M.; Smith, F. J.; Mailen, J. C.; Bell, M. J. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 34: No. 1, 313-20(Jan 1972).

The equilibrium distribution of several lanthanide and actinide elements between liquid bismuth solutions and molten LiCl–LiF and LiBr–LiF salt solutions was determined at 600 to 700°C with salt solutions in which the LiF concentration was varied from 0 to about 25 mole %. At a given temperature, the distribution coefficients (D_M), which are defined as the concentration of M in the bismuth phase divided by the concentration of M in the salt phase, for each solute obeyed the relationship $D_M = (N_{Li}^n)(K_M^*)$ with each salt solution used. In this expression, which is valid for a specific salt composition, N_{Li} is the mole fraction of lithium in the bismuth phase, n is the oxidation number of M^{n+} in the salt phase, and K_M^* is a constant. At a given temperature, the variation of K_M^* with the LiF concentration in the salt phase could be expressed as $\log K_M^* = \log K_{o,M}^* - \log [(1 - N_{LiF})^n + \beta_M N_{LiF}^n]$. In this expression, $\log K_{o,M}^*$ is the value of $\log K_M^*$ obtained with pure LiCl or LiBr as the salt phase and β_M is a constant. (auth)

20150 FAR IR SPECTRA OF SODIUM URANIUM FLUORIDES. Ohwada, K.; Soga, T.; Iwasaki, M. (Japan Atomic Energy Research Inst., Tokai). J. Inorg. Nucl. Chem.; 34: No. 1, 363-5(Jan 1962).

The far ir absorption spectra of $3NaF \cdot UF_4$, $2NaF \cdot UF_4$, $7NaF \cdot 6UF_4$, and $NaF \cdot 2UF_4$ were measured together with the spectrum of UF_4 in the region of 500/cm to 30/cm. The results on UF_4 are in good agreement with data obtained by other authors. It is considered that there is considerable covalency in the U–F linkage. The observed frequencies and suggested assignments of the sodium uranium fluorides listed above are tabulated and discussed.(UK)

20151 KINETICS OF THE OXIDATION OF U(IV) BY Fe(III) IN ORGANIC SOLUTIONS OF TRIBUTYL PHOSPHATE CONTAINING WATER AND PERCHLORIC ACID. Regnault, Patrick; Kikindai, Tivadar (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France. CEN, Fontenay-aux-Roses, France). Compt. Rend., Ser. C; 273: No. 22, 1477-80(29 Nov 1971). (In French).

The oxidation reaction of U(IV) by Fe(III) is of the first order with respect to these constituents. The effect of the following parameters is examined; water content, perchloric acid content, and temperature. The results are quantitatively similar to those obtained in an aqueous perchloric acid medium. (France)

20152 EFFECT OF BUTANOL AND SOME DEGRADATION PRODUCTS OF TRIBUTYL PHOSPHATE ON THE OXIDATION KINETICS OF U(IV) BY Fe(III). Regnault, Patrick; Kikindai, Tivadar (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France. CEN, Fontenay-aux-Roses, France). Compt. Rend., Ser. C; 273: No. 23, 1585-8(8 Dec 1971). (In French).

The degradation products of tributyl phosphate slow down the rate at which U(IV) is oxidized by Fe(III), the effect being more marked with the appearance of more less esterified compounds of H_3PO_4. In contrast, butanol has no effect, even at appreciable concentrations. (France)

20153 KINETICS OF DEHYDRATION OF SINGLE CRYSTALS OF URANYL NITRATE HEXAHYDRATE. Franklin, M. L.; Flanagan, Ted B. (Univ. of Vermont, Burlington). J. Chem. Soc., A; No. 2, 192-6(1972).

The kinetics of dehydration of single crystals of uranyl nitrate hexahydrate to uranyl nitrate trihydrate were followed isothermally, in vacuo from −60 to −30°C. The energy of activation for the dehydration is 46 ± 4 kJ (mol H_2O)$^{-1}$. The dependence of the rate of dehydration upon the ambient water vapor pressure is linear which is unusual. Although the product is crystalline and this is a non-zeolitic dehydration process, it does not occur at the reactant-product interface and, consequently, the usual contracting envelope kinetics do not apply. (auth)

20154 REMOVAL OF ORGANIC IODINE FROM RADIOIODINE-CONTAINING ATMOSPHERES. Soldano, Benadetto A.; Ward, Wilfred T. (to United States Atomic Energy Commission). U. S. Patent 3,630,942. 28 Dec 1971. Filed 17 Feb 1969.

A spray or scrub solution for removing iodine from gases is an aqueous solution adjusted to a pH in the range 9 to 10 with an alkali metal hydroxide such as potassium hydroxide or sodium hydroxide. The solution contains up to 0.3 wt % boron as borate, a reducing agent for molecular or atomic iodine selected from the group consisting of sodium thiosulfate and formaldehyde, and from 0 to an effective amount of a free radical getter, or a material that reacts with hydrated electrons. (auth)

20155 URANIUM OXIDE CATALYST. Nicklin, Thomas; Clack, Joseph; Burgess, Kenneth Harold (to The Gas Council). U. S. Patent 3,630,967. 28 Dec 1971. Priority date 21 Jun 1966, Great Britian.

A process is described for the preparation of a catalyst. A composition comprising a first component, together with a second component, disposed on a catalyst support are subjected to at least two reduction-oxidation cycles. The first component is selected from the group consisting of uranoso-uranic oxide, uranium trioxide, and a mixture thereof and the second component is selected from the group consisting of nickel, nickel oxide, or a mixture thereof. The invention also provides a catalyst when prepared by the method. (auth)

20156 METAL BORANATES AND BORANATOMETALLATES. IV. BORANATO COMPLEXES $M(BH_4)_{4+n}^{n-}$ OF ZIRCONIUM, HAFNIUM, AND THORIUM. Ehemann, Manfred; Noeth, Heinrich (Univ., Munich). Z. Anorg. Allg. Chem.; 386: No. 1, 87-101(Dec 1971). (In German).

Reactions of $LiBH_4$ and R_4NBH_4 with the borohydrides of Zr, Hf, and Th yield thermally stable tetraalkylammoniumpenta(tetrahydrido)borato-metallates of Zr, Hf, and Th as well as $LiTh(BH_4)_5$ and $Li_2Th(BH_4)_6$. However, $LiZr(BH_4)_5$ and $LiHf(BH_4)_5$ decompose into the borohydrido components in vacuo at low temperatures (~−20°). A new method for preparing $Th(BH_4)_4$ is described. ^{11}B NMR and ir spectra of the new complexes are discussed. The BH_4 groups in $Th(BH_4)_{4+n}^{n-}$ are bonded via 3 hydrogen bridges to the metal while two operate in the zirconium and hafnium complexes. (auth)

20157 CHEMICAL REACTIONS IN FUSED SALTS. I. Landresse, G. Ind. Chim. Belge; 36: No. 10, 843-51(Oct 1971). (In French).

In this review article molten salt reactions are divided into three parts: acid-base plus double decomposition reactions, precipitation reactions, and oxidation-reduction reactions. The Lux-Flood concept of acid-base reactions is applied wherein Base ⇌ Acid + O^{2-} represents an equilibrium reaction involving a conjugate acid and base. Discussion of dissolution of metal oxides includes UO_2, UO_3, and ThO_2 in addition to a number of common oxides. Reactions with exchange of O^{2-} are grouped according to whether or not the solvent participates. Review of precipitation studies includes specific studies of precipitation of UO_2 from dissolved UO_2^{2+} and UF_4, reactions between BrO_3^- and U(VI), Np(V), and Np(VI) in a $LiNO_3$–KNO_3 melt, and a separation of Pu from Am by precipitating PuO_2 by treatment with an Ar–O_2 mixture, which leaves Am in solution. (62 references) (K.S.W.)

20158 URANIUM(VI) COMPLEXES OF SOME TRIDENTATE SCHIFF BASES. Mehta, R. K.; Gupta, R. K.; Singhi, V. C. (Univ. of Jodhpur, India). Israel J. Chem.; 9: No. 5, 589-91 (1971).

Protonation constants (log K_1^H and log K_2^H) of N-acetylacetoneanthranilic acid (H_2AA), N-salicylideneanthranilic acid (H_2SA) and N-(2-hydroxy-1-naphthalidene)anthranilic acid (H_2NA), and formation constants of their uranium (VI) complexes were determined potentiometrically in 50% dioxane (vol/vol) solutions (μ = 0.1 M $NaClO_4$) at 30 ± 0.1°C. The stabilities of these complexes were found to be in the order: $UO_2^{+2} - H_2NA > UO_2^{+2} - H_2SA > UO_2^{+2} - H_2AA$. (auth)

20159 PRODUCTION OF PREDOMINANTLY CRYSTALLINE SOLS OF URANIA. McBride, John P.; McCorkle, Kenneth H.; Pattison, William L. (to United States Atomic Energy Commission). U. S. Patent 3,629,133. 21 Dec 1971. Filed 8 Apr 1969.

A method is described for forming a stable, predominantly crystalline sol from an acid-deficient solution of a hydrous metal oxide in which the metal is in the 4+ oxidation state. The solution is heated to a crystallizing temperature to cause an increase in conductivity of the solution, removing the anion at the crystallizing temperature to a condition of further acid deficiency at a rate that approximates the rate of release of free acid to the aqueous phase of the resultant sol, and then adjusting the anion-to-metal ratio of the sol to a desired anion-to-metal ratio. (auth)

20160 VOLATILE COMPLEXES OF SOME LANTHANIDES AND RELATED ELEMENTS WITH FLUORINATED β-DIKETONES AND ORGANOPHOSPHORUS ADDUCTS. Mitchell, James W.; Banks, Charles V. (Ames Lab., Iowa). Anal. Chim. Acta; 57: No. 2, 415-24(Dec 1971).

The behavior of lanthanide trifluoroacetylacetonates and hexafluoroacetylacetonates of mixed complexes with tri-n-butyl phosphate as the adduct was studied by thermogravimetric methods. Thermal properties of mixed ligand–aduct complexes containing new fluoroorganophosphorus donors also were examined. Substantial improvements in volatility and thermal stability of chelates of the lanthanides with either HTFA or HHFA were obtained by displacing the hydrated water with an organophosphorus donor. The thermal stability and volatility of chelates of uranium(IV), uranium(VI), and thorium(IV) were also determined. (auth)

20161 INFRARED SPECTRUM OF MATRIX ISOLATED UO_2(g) AND ITS THERMODYNAMIC PROPERTIES. Abramowitz, S.; Acquista, N. (National Bureau of Standards, Washington, D. C.). J. Phys. Chem.; 76: No. 5, 648-9(2 Mar 1972).

The far-infrared spectrum of $U^{16}O_2$ and $U^{18}O_2$ was observed and assigned. A value of the missing stretching fundamental was estimated. These vibrational frequencies were utilized to estimate the S^0_{2000} for reasonable molecular models. A value of S^0_{2000} of 93.9 ± 2.0 eu is estimated for UO_2(g) to the harmonic oscillator rigid rotor approximation. Any electronic contributions to the S^0_{2000} were neglected and a singlet ground state was assumed. (auth)

20162 DESORPTION OF ^{144}Ce FROM COTTON. Bar, Jaromir; Kostylek, Jaromir (Vojenska Academy, Brno). Jad. Energ.; 17: No. 11, 382-4(Nov 1971). (In Czech).

The action of the disodium salt of EDTA (Complexone III) in concentrations of 0.01 to 0.5% in aqueous solution desorbed micro quantities of the radionuclide ^{144}Ce when the latter was adsorbed on cotton material. The use of EDTA at a pH of 4 to 6 and a concentration of 0.05% is recommended. (tr-auth)

20163 ELECTROCHEMICAL STUDIES OF THE URANIUM(VI)–DIETHYLENE-TRIAMINEPENTAACETIC ACID COMPLEXES. Jacobsen, E.; Kalland, G. O.; Lykkjen, O. (Univ. of Oslo). Anal. Chim. Acta; 58: No. 1, 193-201(Jan 1972).

The electrochemical reduction of uranium(VI) in the presence of excess of DTPA was studied by polarography, cyclic voltammetry, and coulometry at controlled potential. Above pH 6 a complex with cation–ligand ratio 1:1 is formed. At mercury electrodes the complex is reversibly reduced to a uranium(V)–DTPA

complex. The reduction product is unstable and disproportionates to uranium(VI) and uranium(IV). At pH values below 5 a complex with a cation–ligand ratio 2:1 is formed. This complex is irreversibly reduced to uranium(V). The diffusion current constants and polarographic behavior of the two complexes are described. (auth)

Radioactive Waste Treatment

Refer also to abstracts 20147, 20291, 20957, 20960, 20961, and 22231.

20164 ADSORPTIVE BUBBLE SEPARATION TECHNIQUES. Lemlich, Robert (ed.). New York; Academic Press Inc. (1971). 344p. $17.50.

Chapter 1 introduces the various adsorptive bubble separation techniques. Chapter 2 deals with certain pertinent properties of foam which are common to many of them. Chapters 3 through 8 individually discuss several of these techniques: namely, foam fractionation, ion flotation, precipitate flotation, mineral flotation, bubble fractionation, and solvent sublation. The remaining chapters 9 through 20 summarize the results of numerous separations. Separate abstracts were prepared for 3 of the chapters. (D.H.M.)

For abstracts of individual chapters see: 20024, 20165, and 20166.

20165 SEPARATION OF SURFACTANTS AND METALLIC IONS BY FOAMING: STUDIES IN FRANCE. Arod, J. (CEN, Cadarache, France). pp 243-8 of Adsorptive Bubble Separation Techniques. /Lemlich, Robert (ed.). New York; Academic Press Inc. (1971).

A study was made of the use of foam separation in the decontamination of radioactive wastes of medium-level activity, in which the principal radioisotopes were ^{90}Sr, ^{137}Cs, and ^{144}Ce. The application of the process to decontamination of a real waste although it is limited, is not very encouraging. This is not because of low decontamination factors, but because of the great chemical and, above all, hydrodynamic interferences. It is not unthinkable to consider the application of this method to the recovery and separation of traces of expensive nuclear materials for which the restrictions of cost are less severe, and the flow rates and the constancy of the solutions more compatible with the possibilities of foam separation. (D.H.M.)

20166 SEPARATION OF SURFACTANTS AND METALLIC IONS BY FOAMING: STUDIES AT RADIATION APPLICATIONS, INC., AND OAK RIDGE NATIONAL LABORATORY, U.S.A. Davis, W. Jr.; Haas, P. A. (Oak Ridge National Lab., Tenn.). pp 279-97 of Adsorptive Bubble Separation Techniques. /Lemlich, Robert (ed.). New York; Academic Press Inc. (1971).

A study of the technical and economic feasibility of developing a foam separation process for decontaminating the slightly radioactive process waste water that is generated in large quantities at all nuclear reactor and fuel processing sites is reviewed. The assessment of the process included laboratory and small-scale engineering tests; it concluded with a pilot plant demonstration with a 2- by 2- by 8-ft foam column. (D.H.M.)

20167 REGENERATION OF SORPTION PROPERTIES OF ACTIVATED CARBON USED IN THE IODINE INDUSTRY. Galkin, V. A.; Golubev, V. N.; Chernova, R. P. Khim. Prom. (Moscow); No. 1, 46-8(Jan 1972). (In Russian).

Optimum parameters were determined for regenerating industrial samples of activated carbon used for absorbing iodine from iodine plant waters. Progressive regeneration, using 5 to 6 cycles with superheated steam at 800°C, is recommended. A flow diagram for scale-up of the laboratory process is provided. (K.S.W.)

20168 SCRAP NUCLEAR FUEL MATERIAL RECOVERY PROCESS. Welty, R. K. (to General Electric Co.). Canadian Patent 888,105. 14 Dec 1971.

Scrap UO_2 from the manufacture of nuclear fuel pellets is recovered by passage through a fluidized-bed reactor. The process consists of crushing and feeding the scrap UO_2 into a fluidized-bed reactor, passing gas containing oxygen at 400 to 600°F into the reactor in an amount at least twice the stoichiometric quantity to complete the oxidation reaction for the smallest particles to U_3O_8, heating the reactor to 800 to 1300°C, controlling the gas flow so that the largest particles are not fluidized, the medium-sized, partly oxidized particles are fluidized, and the smallest completely oxidized are carried out the top of the reactor. The smallest particles are separated from the gas after they have been carried from the reactor by the gas. The reactor has an inside diameter less than ten inches. The smallest particles are reduced by hydrogen back to the original oxide state whereby finely divided, millable, sinterable particles are produced. (F.S.A.) (Canada)

Radioisotope Production

Refer also to abstracts 20556, 21830, and 21870.

20169 (COO-1167-17) TECHNICAL PROGRESS REPORT ON NUCLEAR CHEMISTRY RESEARCH, DECEMBER 15, 1970–DECEMBER 31, 1971. Sugarman, Nathan; Turkevich, Anthony (Chicago Univ., Ill. Enrico Fermi Inst.). Contract AT(11-1)-1167. 24p. Dep. NTIS.

Progress is reported on numerous projects including: production of ^{149}Tb, production of rare earth nuclides by proton bombardment of uranium, reactions of 440-MeV and 12-GeV protons with ^{209}Bi, recoil products from proton bombardment of uranium, production of ^{26}Al, and production of ^{22}Na. (M.C.G.)

20170 GREAT NEW ELEMENTS RACE (DIVISION 104). Keller, O. L. Comments Nucl. Particle Phys.; 5: No. 1, 20-5(Jan-Feb 1972).

A review is presented of recent work on heavy transuranium element discovery at Berkeley (USA), Dubna (USSR), and Oak Ridge. Special reference is made to the discovery of Element 104, and the conflicting views of the U.S. and USSR groups. It is stated that in the case of the Berkeley nuclides it appears possible to apply Moseley's law, relating characteristic x-ray energies to Z, for a definitive identification, and experimental work in this connection is in progress at Oak Ridge. The Berkeley "mother-daughter" experimental work is discussed; this method has the high sensitivity required for studying a few atoms per hour of new α activities, and is the most powerful method available for identifying transmendelevium elements, since it can relate the nuclear properties of two isotopes genetically. Application of the method to Element 104 is described, including criticisms by the Dubna group. The difficulties associated with studying the chemistry of Element 104 are also pointed out, and the Dubna experiments based on gas chromatography are briefly described. The discovery by the Dubna group of fission isomers, thought to be nuclear matter in a new shape, is mentioned, together with work on (p,Xn) reactions. A serious possibility is that the "Element 104" may be a fission isomer of some element below 104. (5 references). (UK)

20171 FORMATION OF ISOTOPES OF ^{227}Ac AND ^{228}Th DURING RADIUM IRRADIATION IN SM-2 REACTOR. Karalova, Z. K.; Ivanov, R. N.; Myasoedov, B. F.; (and others). At. Energ. (USSR); 32: No. 2, 119-22(Feb 1972). (In Russian).

Results of chemical processing of a sample of irradiated ^{226}Ra to determine accumulations of ^{227}Ac and ^{228}Th are presented. The ^{227}Ac and ^{228}Th separation is described, the yield of isotopes estimated, and the degree of impurity removal determined. A quantity of 15.44 mg of radium in the form of $RaCO_3$ calcined at 700°C was irradiated in an SM-2 reactor by a 1×10^{15} neutrons/$cm^2 \cdot$ sec flux of thermal neutrons. The processing scheme consisted of dissolving the sample in nitric acid and separating actinium and thorium from the radium, separating thorium in the form of a nitrate complex on the anion-exchanger AU-23M, followed by purification of actinium by extraction, using a PMBP solution in a mixture of benzene and octanol. The determination of ^{227}Ac and ^{228}Th was carried out by α spectrometry. It was found that for the indicated irradiation parameters ^{227}Ac accumulation for the given ^{226}Ra sample amounted to 2.15% (0.303 + 0.05 mg) and ^{228}Th 4.72% (0.730 + 0.147 mg). (auth)

20172 ^{113m}In GENERATOR USING ZIRCONIUM TUNGSTATE. Kawashima, Tatsuro (Government Industrial Research Inst., Nagoya, Japan). Radioisotopes (Tokyo); 20: No. 12, 660-4(Dec 1971). (In Japanese).

A ^{113m}In generator was prepared using a zirconium tungstate column. The zirconium tungstate was prepared by mixing aqueous solutions of zirconium oxychloride and sodium tungstate to form a white precipitate, which on drying formed semi-transparent granules. X-ray diffraction patterns indicated that the zirconium tungstate was amorphous. The zirconium tungstate was hard and glassy and suitable for use in column operation as an inorganic ion exchanger. The long-lived ^{113}Sn was loaded on the column and the short-lived daughter ^{113m}In was eluted out rapidly with 0.04N HCl. In each milking sequence with 4 to 6 ml of 0.04N HCl, the amount of ^{113}Sn was found to be less than 10^{-4} times the original activity, and the yield of ^{113m}In was about 50% of the ^{113m}In on the generator. The breakthrough of Zr and W into eluates from the generator, measured by the microchemical spot tests using the ion-exchange resin, was 0 to 0.3 μg Zr/ml and 0 to 4.0 μg W/ml, respectively. (auth)

20173 RADIOCHEMICAL SEPARATION OF CARRIER-FREE ^{52}Fe FROM CHROMIUM-TARGET BY ISOPROPYL ETHER EXTRACTION. Akiha, Fumimasa (Hirosaki Univ.,

Japan); Murakami, Yukio. Jap. Anal.; 20: No. 12, 1530-7 (Dec 1971). (In Japanese).

In connection with the practical production of ^{52}Fe formed by bombardment of ^{3}He and α particles on natural chromium, the solvent extractions of carrier-free ^{52}Fe with isopropyl ether (IPE) and methylisobutyl ketone (MIBK) from chromium targets and other byproduced radioactive isotopes are investigated. The extractability and the separation conditions of Fe(III), V(IV), Cr(III) and Mn(II) from hydrochloric acid solution were examined in detail by use of ^{59}Fe, ^{48}V, ^{51}Cr and ^{54}Mn tracers. The advantage and the disadvantage of both methods are discussed giving considerations to high radiation level, rapidness and radiochemical purity. It was shown that the radioactive iron can be separated in carrier-free state from the chromium and others by isopropyl ether, which is superior to methyl-isobutyl ketone. In the production process, use was made of a natural chromium metal target of about $70 \times 20 \times 0.5$ mm dimension electroplated on a copper block; after the electroplating, silver is also electroplated on the copper surface to get a target assembly from which the chromium is easily dissolvable into warm hydrochloric acid. Thus, by making use of remarkable difference of extractability of Fe(III) from that of V(IV), Cr(III) and Mn(II) in IPE, the extraction of ferric iron can be efficiently performed at the acidity of 8N hydrochloric acid solution. The separation seemed to be troublesome, because of the tendency of chromium to form passive state, but it was found that O_2-bubbling has a very large accelerating effect on the dissolution of the irradiated chromium. It is thought that the increase in the dissolution rate is probably due to not only the minor impurity formed in the chromium target in the course of the irradiation, but also the dissolution was carried out as it was plated on the copper surface. Extraction of the ^{52}Fe from the hydrochloric acid solution into isopropyl ether suits well for the remote-controlled technique. The extracted ^{52}Fe is taken out from the remote-handling cell, then it is back-extracted into water and supplied to medical researchers. (auth)

Reactor Fuel Reprocessing

Refer also to abstracts 19943, 20022, 20026, 20030, and 20312.

20174 (CEA-R-4189) CONTRIBUTION TO STUDY OF TRANSITORY REGIMES IN MIXER-SETTLERS: EXTRACTION OF URANIUM. Rouyer, Hubert (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov 1971. 97p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, France.

A survey is made of the literature concerned with the calculations on transient operation in multistage countercurrent systems. The difficulties encountered in solving these problems with digital computers are discussed. The use of an analog computer is proposed. New developments in this field and that of hybrid computers are described. The physicochemical factors concerned with the extraction of uranium(VI) with 30% tri-n-butyl phosphate were studied. A mathematical model is proposed, which can be simulated with a standard analog computer and takes into account the two main solutes that are extracted, uranium and nitric acid. The effect of a change in the inlet feed concentration is studied by comparing the experimental results with those obtained by a computer simulation. The experimental procedure and the mixer-settler, which is a subcritical device, are described. When the change is positive, the behavior of the organic and aqueous phases in the settler must be distinguished, while the mixer may be considered as perfectly mixed with instantaneous mass transfer. In the organic phase, "equiconcentration" surfaces of the settler are horizontal and are displaced vertically near the free surface. The volume of the organic phase that is not submitted to this kind of "piston flow" may be considered as perfectly mixed. This mixture results from the momentum of the emulsion flowing down from the mixer weir. This momentum is shown to have no influence on the behavior of the aqueous phase of the settler, which is almost perfectly mixed. This mixing is caused by natural convection resulting from specific gravity differences during transient operation. When uranium and nitric acid are simultaneously extracted, comparison between simulation and experiment demonstrates that an additional mass transfer occurs in the dispersion triangle. This phenomena is even more evident in the case of a four-stage extraction section. The principles applied in making the calculations with an analog and with a hybrid computer are described in an appendix. (auth)

20175 (DOCKET-50201-109) WEST VALLEY REPROCESSING PLANT. Request for Additional Information on Proposed High-Level Waste Storage Facility. (Division of Materials Licensing (AEC), Washington, D. C.). 25 Feb 1972. 4p. Dep. NTIS.

20176 (DOCKET-50201-110) WEST VALLEY REPROCESSING PLANT. Technical Specifications, Change 17. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 6 Mar 1972. 2p. Dep. NTIS.

A proposed change to technical specifications authorizes the quantities of radioisotopes necessary to support development of the low-level waste treatment plant and expansion of the environmental monitoring program. (M.C.G.)

20177 (EUR-4708) EUREX EURATOM-CNEN AGREEMENT. Annual Report, 1970. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1972. 20p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR FB 40,-.

The progress of the EUREX project (Reprocessing Plant) is described. Administrative considerations are mentioned. A bibliography refers to more technical documents and reports. (auth)

20178 (IAEA-115) REPROCESSING OF HIGHLY IRRADIATED FUELS. Report of a Panel of Experts Held in Vienna, May 27-30, 1969. (International Atomic Energy Agency, Vienna (Austria)). 1970. 389p. (In several languages). (CONF-690535). INIS.

Twenty-one papers presented at the meeting are included. Separate abstracts were prepared for 13 papers. Eight papers were previously abstracted for NSA. For abstracts of these see 23: 47586, 49881, 49882, 49883, 49884, 49885, 49886, and 49894. (M.C.G.)

For abstracts of individual papers see: 20179-20191.

20179 (IAEA-115, pp 115-28) STATUS OF WORK IN THE UNITED KINGDOM. Warner, B. F. (United Kingdom Atomic Energy Authority, Sellafield (England). Production Group). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

The organization in the UKAEA that is concerned with reprocessing is outlined. The way in which the Second Windscale Plant was adapted to process high burnup oxide fuel by the addition of a Head-End Plant is described and design and operational experience in the processing of MTR and Experimental Fast Reactor fuel at Dounreay are given. Areas in which the major problems of processing Fast Reactor and Advanced Thermal Reactor fuels are likely to be met are indicated. (auth)

20180 (IAEA-115, pp 129-36) STATUS REPORT ON FUEL REPROCESSING EXPERIENCE AND REVIEW OF PROGRAMME IN INDIA. Srinivasan, N. (Bhabha Atomic Research Centre, Bombay (India)). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

Experience in reprocessing natural uranium metallic fuel from a heavy-water-moderated research reactor was gained in a demonstration plant at Trombay. A 500-kg per day plant for reprocessing BWR and Candu type fuels is under construction. A demonstration reprocessing plant for fast reactor fuel is planned. Development work on a modest scale is in progress on the direct chlorination volatility process, recovery of neptunium from power reactor fuel, use of trilaurylamine for solvent extraction of plutonium, investigations on suitable partition agents, and separation of ^{233}U from irradiated thorium and thorium oxide. (auth)

20181 (IAEA-115, pp 137-48) REPROCESSING OF HIGHLY IRRADIATED FUELS: SOME ALTERNATIVES. Srinivasan, N. (Bhabha Atomic Research Centre, Bombay (India)). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

The problems of the presently known methods of reprocessing, both aqueous and nonaqueous, are discussed. A hybrid flowsheet, selecting the most suited process for each step of the flowsheet, is presented. The flowsheet suggests shearing of the fuel, oxidative removal of volatile fission products, nitric acid dissolution, amine extraction of plutonium, and fluoride volatility decontamination of uranium consigning high active waste to the fluorinator solid residue. (auth)

20182 (IAEA-115, pp 149-65) PYROCHEMICAL SEPARATION OF PLUTONIUM FROM IRRADIATED FUELS. Avogadro, A.; Wurm, J. G. (European Communities, Brussels (Belgium). Commission. European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

The pyrochemical flowsheet described is based on a hybrid

molten salt–aqueous fuel cycle for the separation of plutonium in high-burnup fuels. A plutonium concentrate is extracted on the reactor site by means of a molten salt and its final purification is achieved by an aqueous method. The pyrochemical reactions involved proceed in two steps: the chopped or declad fuel is first submitted to an oxidation–desegregation step with molten $NaNO_3$ in which insoluble uranates and plutonates are formed and in the second step the uranates and plutonates in suspension in a chloride flux ($MgCl_2$–NaCl) are submitted to an HCl + O_2 oxychlorination reaction, which transforms the uranate into soluble UO_2Cl_2 and the plutonate into insoluble PuO_2. This latter is separated by filtration and purified by an aqueous method. The uranium is recovered as UO_3 through MgO precipitation. The hybrid fuel cycle combines all the advantages of dry and aqueous methods and minimizes their respective disadvantages. This opens the way to shorter cooling times, reduced fuel transportation costs, simplification of the aqueous processing plant, and savings in waste disposal. It could be applied as well for the processing of low Pu thermal fuels as for the processing of highly irradiated fast breeder fuels. Both ways are described and discussed. (auth)

20183 (IAEA–115, pp 167-200) LIQUID METAL DECANNING OF HIGHLY IRRADIATED UO_2–PuO_2/STAINLESS STEEL CLAD FUELS. Wurm, J. G.; Payrissat, M. (European Communities, Brussels (Belgium). Commission. European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

A decanning process for fast breeder fuels of the UO_2–PuO_2/stainless steel type was investigated. The method is based on a selective dissolution of the stainless steel cladding material in a liquid metal solvent composed of Sb–Cu at temperatures between 800 and 950°C. The stainless steel dissolution rates, which vary between 40 and 60 wt %, are strongly temperature dependent. The crucible is graphite. The fuel UO_2–PuO_2 is separated from the liquid solvent by filtration. Microprobe examinations showed that after solidification the structure of the solvent alloy including stainless steel is rather uniform. The liquid metal dissolution process offers advantages over mechanical or chemical decladding methods, particularly for highly irradiated fuels. The presence of Na would not be of great concern since Na is slightly soluble in the Sb–Cu alloy. The dissolution can be performed without disassembly of the fuel element. The fission gases are evacuated and condensed in a minimum volume. The whole decanning process can be carried out with very compact equipment located on the reactor site. (auth)

20184 (IAEA–115, pp 201-23) DEVELOPMENT OF REPROCESSING PROCEDURES FOR THORIUM-CONTAINING FUEL ELEMENTS. Fischer, E.; Kaiser, G.; Laser, M.; Merz, E.; Riedel, H. J.; Witte, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

Three different reactor concepts are presently considered for application in the thorium–uranium cycle, the high-temperature gas-cooled thorium reactor, the heavy-water-moderated thorium reactor, and the molten-salt thorium breeder. For each of them suitable reprocessing procedures have to be developed. Work was directed towards the development of suitable reprocessing procedures for the graphite fuel elements of HTG reactors as well as for the metal-canned fuel elements considered for the planned heavy-water-moderated thorium reactor. The fuel elements of HTG reactors require a special head-end step, because a considerable amount of the moderator graphite is introduced into the actual reprocessing and fuel particles have chemically resistant coatings of pyrocarbon or silicon carbide. Two different approaches were investigated and developed: the burning of the graphite and pyrocarbon, respectively, in a fluidized bed without the addition of alumina, and the chlorination of finely ground fuel elements with chlorine in a fluidized bed reactor at temperatures between 800 and 1000°C. The volatilized chlorides of thorium, uranium, and most fission products are condensated and further separated and purified by solvent extraction. Also sparingly soluble thorium and uranium oxides, obtained in the case of removing the graphite by combustion, are dissolved in a potassium pyrosulfate melt and their aqueous solutions further treated by solvent extraction. Prior to the solvent extraction step, the protactinium present in the feed solution is removed by a selective adsorption technique. Then the solution is concentrated by evaporation, during which the thorium is completely precipitated as the potassium sulfatothorate; it can be separated from the uranium solution and directly stored as medium level waste. (auth)

20185 (IAEA–115, pp 225-46) STATUS OF REPROCESSING OF HIGHLY RADIOACTIVE FUELS IN THE USA. Buckham, J. A. (Idaho Nuclear Corp., Idaho Falls). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

Much of the current fuel reprocessing development work in the USA is directed toward reprocessing fuels that are highly radioactive, because of both higher irradiation levels and shorter cooling times. Aqueous reprocessing technology appears to be the most suitable for the highly radioactive fuels. The problems created in this by higher radioactivity levels and some possible solutions to these problems are discussed. Limited processing experiences with such fuels are described. Backup technology can be developed in the form of pyrometallurgical and volatility processing, and these processes may be more suitable in some cases. The status of technology for these two processes is summarized. (auth)

20186 (IAEA–115, pp 247-55) CONTROL OF FISSION PRODUCT ACTIVITY DURING SHORT-COOLED FUEL PROCESSING CONNECTED WITH THE ICPP RALA PROCESS. Bower, J. R.; Buckham, J. A. (Idaho Nuclear Corp., Idaho Falls). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

A process for recovery, within a 24-hr period, of 50,000 curies of ^{140}Ba from two-day-cooled MTR fuel elements is operated. The accompanying 25,000 curies of ^{131}I released during dissolution and processing is trapped by scrubbers, charcoal adsorbers, and filters, allowing only approximately one curie to be released to the atmosphere. (auth)

20187 (IAEA–115, pp 257-66) EFFECT OF IRRADIATION ON THE DISSOLUTION CHARACTERISTICS OF IMPORTANT FUEL AND CLADDING MATERIALS. Rohde, K. L.; Buckham, J. A. (Idaho Nuclear Corp., Idaho Falls). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

Reactor irradiation can have significant effects on the dissolution rates of fuel and cladding materials in various aqueous reagents due to changes in composition and structure. Reported data on these effects are reviewed. Aluminum-3% uranium and aluminum-7% plutonium alloys become more passive. Zirconium-4% uranium alloy becomes more reactive, while Zircaloy-2 cladding on the alloy becomes slightly less reactive. The reactivity of Type 304 stainless steel changes very little with fast neutron irradiation. Uranium oxide-plutonium oxide and thorium oxide-uranium oxide appear to change little or become more reactive. (auth)

20188 (IAEA–115, pp 311-25) PRESENT STATUS AND ORGANIZATION OF ADVANCED FUEL REPROCESSING IN THE FEDERAL REPUBLIC OF GERMANY. Schueller, W. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen m. b. H., Leopoldshafen bei Karlsruhe (West Germany)). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

Research and development efforts in the field of fuel reprocessing are summarized. The Karlsruhe work is mainly directed towards the adaptation of aqueous solvent extraction methods to the processing of high-burnup uranium–plutonium fuels of advanced thermal and fast breeder reactors. The Jülich Center is working on reprocessing of thorium fuels for high-temperature gas-cooled reactors, for which Thorex or nonaqueous processing methods are considered as alternatives. Germany's first reprocessing plant (WAK) with a capacity of 200 kg UO_2/day will aid in the training of personnel, accumulation of plant experience, and for the technical-scale demonstration of reprocessing methods for advanced fuels. (auth)

20189 (IAEA–115, pp 327-50) REPROCESSING OF JAPAN EXPERIMENTAL FAST REACTOR FUEL IN A PUREX PROCESSING PLANT. Sato, Shigeru; Hoshino, Tadaya (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)); Naito, Keiji (Nagoya Univ. (Japan)). 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

A fuel-reprocessing plant design based on the Purex Process was selected for reprocessing fast breeder fuels. It will be used to process two types of fuel: magnox clad natural uranium irradiated to 3,900 MWD/t and cooled 155 days and zircaloy or stainless steel-clad 4% enriched uranium oxide fuel irradiated to 28,000 MWD/t and cooled 180 days. (M.C.G.)

20190 (IAEA–115, pp 351-69) FUEL ELEMENT CHARACTERISTICS IN THERMAL AND FAST NEUTRON REACTORS. Shevchenko, V. B. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1970. (In Russian).

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

Fuel elements for the Novo-Voronezh reactor and for the Belo-

yarsk reactor are chiefly considered here. Specifications, fission product activities, and cutting of these fuel elements including cladding removal are summarized. One proposed method involved melting the stainless steel from the spent oxide fuel at 1,670 to 1,720°C. Subsequent dissolution in HNO_3 and TBP extraction are considered in some semi-quantitative aspects. A contrasting discussion of the reprocessing of thermal neutron reactor fuel with the reprocessing of fast reactor fuel is presented. The behavior of ^{85}Kr and ^{131}I as problematic fission products during the extraction process is analyzed. (K.S.W.)

20191 (IAEA–115, pp 383-5) SUMMARY AND RECOMMENDATIONS OF THE PANEL ON REPROCESSING OF HIGHLY IRRADIATED FUELS TO THE IAEA. 1970.

From IAEA panel on reprocessing of highly irradiated fuels; Vienna, Austria (27 May 1969).

20192 (RT/ING–(71)18) COMMISSIONING OF THE ITREC PLANT. Orsenigo, G.; Piatti Forni, U.; Vallone, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 18 Nov 1971. 54p. Dep. NTIS (U. S. Sales Only).

Principles of design and processes of the ITREC plant are summarized. Operation of the fuel element receiving and dismantling processes is described. Results of cold runs on the reprocessing plant are given. (auth)

20193 CRITICALITY INCIDENT AT WINDSCALE. Hughes, T. G. (British Nuclear Fuels Ltd., Windscale, Eng.). Nucl. Eng. Int.; 17: No. 189, 95-7(Feb 1972).

A description is given of the criticality incident that occurred on Aug. 24, 1970, at the Windscale plutonium recovery plant, when higher than normal radiation levels were recorded. Procedures adopted in tracing the cause are detailed. The trouble was located in a transfer pot through which liquid from the treatment vessel passed before entering a metering reservoir. The sequence of events leading to criticality are discussed. Recommendations of the Board of Enquiry are referred to. (UK)

20194 REDOX EXTRACTION IN LIQUID METAL (Pb–Bi)-MOLTEN SALT ($AlCl_3$–LiCl) SYSTEMS. Kertes, A. S.; Foos, J.; Levy, O.; Guillaumont, R. (Institut de Physique Nucleaire, Orsay, France). J. Inorg. Nucl. Chem.; 34: No. 1, 321-7(Jan 1972).

The distribution of micro-quantities of metals between two immiscible phases, those of liquid Pb-Bi alloy and molten $AlCl_3$-LiCl mixtures was measured at 200°C, as a function of the $AlCl_3$/LiCl mole ratio in the range between ~1 and ~5. At any given composition of the melt the distribution ratio (metal in the alloy phase/metal in the salt phase) increases in the order In < Cd < Fe < Co < Hg < Ag, indium being practically completely in the salt phase, while silver and mercury are in the alloy phase. With the exception of indium, the distribution of the metals depends largely on the free energies of formation of their chlorides. The displacement of indium appears to be due to the formation of stable complexes with either or both the $Al_2Cl_7^-$ and $AlCl_4^-$ anions. For any given metal the distribution ratio increases as the $AlCl_3$/LiCl ratio approaches unity. Since $AlCl_3$ (or its complexes) is the oxidizing agent in the redox extraction system, the phenomenon is explained by a variation of the apparent standard potential of the Al^{3+}/Al^0 couple in the melts. (auth)

20195 METHOD OF MAINTAINING VARIABLE DENSITY DISSOLVER SOLUTIONS CRITICALLY SAFE. Rhodes, Donald W. (to United States Atomic Energy Commission). U. S. Patent 3,629,134. 21 Dec 1971. Filed 7 Apr 1969.

A dissolver vessel can be made critically safe during the dissolution of nuclear fuel by adding insoluble particulate poisons to the dissolvent. The insoluble poison particles have a density range so that a sufficient amount of poison is always in suspension even though the dissolvent changes density during the dissolution process. (auth)

20196 REPROCESSING. Terjesen, S. G. (Norsk Hydros Institutt for Kreftsforskning, Oslo). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 86, 18-28(Nov-Dec 1970). (In French). (CONF-700903–22).

From fourth Foratom Congress on industrial aspects of the nuclear fuel cycle in Europe; Stockholm, Sweden (21 Sep 1970).

The significance of reprocessing in the LWR fuel cycle costs is examined. The short- and long-term reprocessing requirements are considered. Existing and possible future reprocessing plants in Europe are discussed. A large overcapacity and severe competition between small subsidized plants and large plants with favorable financial conditions characterize the European situation. The construction of a new European plant designed for the reprocessing of fuels from various small countries is planned. (France)

ENGINEERING

Energy Conversion

Refer also to abstracts 20236 and 21355.

20197 (GEMP-286) BRAYTON CYCLE STUDY. Semple, E. L.; Simpson, J. D. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). 15 May 1964. 15p. Dep. NTIS.

A study was performed to compare the characteristics of a 1 MW(e) space power system operating on the Brayton cycle with either argon or neon. A straightforward gas cycle without recuperation was used in the analysis. The results of the study are compared on the basis of heat rejection requirements as a function of selected variables, and reactor weight comparisons are shown. (L.C.L.)

20198 (GEMS-2048-1(Vol.1)) 250-WATT RADIOISOTOPE THERMOELECTRIC POWER SYSTEM. VOLUME I. SUMMARY. Final Report, June 30, 1966–December 31, 1966. Gross, M. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Contract AT(29-2)-2048. 44p. (66-SD-2044-A). Dep. NTIS.

Declassified 18 Oct 1971.

A study was performed to develop a radioisotope thermoelectric generator concept, using either ^{238}Pu or ^{90}Sr heat sources, which would permit return of the fuel, intact in its containment to pre-selected target areas on earth. Information is included on: system configuration; safety approach; radioisotope thermoelectric generator reference design; controlled intact reentry package; ground handling equipment; and integration of the power system in the Voyager vehicle. It was concluded that the controlled intact reentry package concept is feasible and can be implemented by development efforts using current state-of-the-art equipment. (L.C.L.)

20199 (GEMS-2048-1(Vol.2)(Pt.2)) 250-WATT RADIOISOTOPE THERMOELECTRIC POWER SYSTEM. VOLUME II. PART 2. POWER SUPPLY TECHNICAL DESCRIPTION. Final Report, June 30, 1966–December 31, 1966. Gross, M. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Contract AT(29-2)-2048. 564p. (66-SD-2000-2A). Dep. NTIS.

A final report on studies related to developing a 250 W(e) ^{238}Pu- or ^{90}Sr-fueled thermoelectric space power system is presented. Information is included in this volume on: space interface definitions; safety analysis of operational aspects of the power system and the system response to accident environments; power supply system alternatives; subsystem technologies and tradeoffs; configuration selection, and systems specification. (L.C.L.)

20200 (GEMS-2055-1(Vol.1)) ISOTOPE THERMIONIC MODULE DEVELOPMENT PROGRAM. VOLUME I. PHASE I SUMMARY. Final Report, June 30, 1966–February 28, 1967. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 28 Feb 1967. Contract AT(29-2)-2055. 50p. (67-SD-2021). Dep. NTIS.

The development of preliminary designs for 100 W(e) isotope thermionic modules using ^{244}Cm and ^{210}Po as fuels is described. These modules are to serve as basic electric power units which, in multiples, can be used to supply spacecraft power requirements in the 0.5 to 2 kW range. Information is included on the design requirements, module reference designs, conceptual power system design, preliminary safety analysis, and plan for development program. From this preliminary design study it was concluded that the modules are compatible with a variety of space missions, and, as compared with radioisotope thermoelectric generators, have the advantages of higher efficiency (~12%), high heat rejection temperature (~500°C), high specific weight (7 to 8 W/lb vs 1.5 W/lb), and smaller size. (L.C.L.)

20201 (GEMS-2055-1(Vol.2)(Pt.2)) ISOTOPE THERMIONIC MODULE DEVELOPMENT PROGRAM. VOLUME II. PRELIMINARY DESIGN. PART 2. Final Report, June 30, 1966–February 28, 1967. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 28 Feb 1967. Contract AT(29-2)-2055. 306p. (67-SD-2021). Dep. NTIS.

Declassified 18 Oct 1971.

To ensure that the preliminary isotope thermionic module designs are compatible with a variety of space applications, space power system conceptual designs were developed for three space missions, i.e. Voyager, Manned Orbiting Laboratory (MOL), and Lunar Scientific Survey Module (LSSM). Information is presented on: conceptual power system design; requirements for, and design, performance and use of power conditioning equipment; nuclear safety analysis; and fuel form evaluation. (L.C.L.)

20202 (GEMS-2055-1(Vol.3)) ISOTOPE THERMIONIC MODULE DEVELOPMENT PROGRAM. VOLUME III. PROGRAM PLANS. Final Report, June 30, 1966–February 28, 1967. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 28 Feb 1967. Contract AT(29-2)-2055. 194p. (67-SD-2020). Dep. NTIS.

Program plans and schedules for developing 100 W(e) ^{244}Cm- and ^{210}Po-fueled thermionic modules for spacecraft power systems are described in detail. (L.C.L.)

20203 (GEMS-2055-1(Vol.4)App.(Pt.1)) ISOTOPE THERMIONIC MODULE DEVELOPMENT PROGRAM. VOLUME IV. APPENDICES. PART 1. Final Report, June 30, 1966–February 28, 1967. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 28 Feb 1967. Contract AT(29-2)-2055. 396p. (67-SD-2015). Dep. NTIS.

Details of the program for developing ^{244}Cm- and ^{210}Po-fueled thermionic converters for space power systems are presented. Information is included on: fuel form selection; selection of flight qualification environments; performance and design requirements for thermionic module; diode parametric performance calculations; module performance calculations; thermal analyses; and static stress analyses. (L.C.L.)

20204 (GEMS-2055-1(Vol.4)(App.)(Pt.2)) ISOTOPE THERMIONIC MODULE DEVELOPMENT PROGRAM. VOLUME IV. APPENDICES. PART 2. Final Report, June 30, 1966–February 28, 1967. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 28 Feb 1967. Contract AT(29-2)-2055. 318p. (67-SD-2015. Dep. NTIS.

Declassified 18 Oct 1971.

Details of the program for developing ^{244}Cm- and ^{210}Po-fueled modular thermionic converters for space power systems are presented. Information is included on: dynamic stress analysis; thermionic diode test program; parametric reentry trajectory data; ^{244}Cm criticality evaluation; estimates of fuel form physical properties; fuel mass transport; module safety design specifications; corrosion analysis; and power conditioner sample calculations. (L.C.L.)

20205 (GEMS-3526-2(Vol.1)) PRELIMINARY DESIGN AND SAFETY STUDIES OF LARGE RADIOISOTOPE HEAT SOURCES FOR SPACE POWER. VOLUME I. SUMMARY, SAFETY AND DESIGN. Final Technical Progress Report, April 15, 1965–October 15, 1965. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 24 Jan 1966. Contract AT(30-1)-3526. 370p. (65-SD-4508-1A). Dep. NTIS.

Preliminary design and safety studies of large heat sources of ^{244}Cm, ^{210}Po, and ^{238}Pu for 1 to 10 kW(e) space power systems using either thermoelectric or Rankine or Brayton power conversion subsystems are described. Information is included on: heat source configuration; safety evaluations; fuel capsule evaluations; emergency cooling; shielding requirements; power system design; heat source recovery; fuel handling; and future development plans. (L.C.L.)

20206 (GEMS-NS-103) SNAP-17B POWER SUPPLY DEVELOPMENT PROGRAM. PRELIMINARY SAFETY ANALYSIS, PHASE I STATUS. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 15 December 1964. Contract AT(30-1)-3308. 160p. (64-SD-878). Dep. NTIS.

Details of a preliminary safety analysis of the ^{90}Sr-fueled SNAP-17B thermoelectric generator for space power systems are presented. This analysis was performed to assess the hazards associated with operating this power system under normal and accident conditions, to recommend design modifications as indicated by the safety analysis, and to recommend a development and testing program to verify the analytical conclusions. Information is included on: safety criteria and specifications; system description; fuel form evaluation; operational considerations; and safety analysis for ground handling, launching, and reentry. Appendixes are included on the thermal aspects of a SNAP-17B capsule buried in sand; analytical techniques for burnup analyses, and generator destruct systems. (L.C.L.)

20207 (GEMS-NS-111) 40 WATT ^{238}Pu POWER SUPPLY ENGINEERING STUDY. (PHASE I). Final Technical Report. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 15 Jan 1965. Contract AT(30-1)-3412. 242p. (64-SD-5033). Dep. NTIS.

The results of a 15-week engineering study of a 40 W(e) ^{238}Pu-fueled thermoelectric generator for the Surveyor Lunar Roving Vehicle (SLRV) are reported. A preliminary power supply design was prepared and analyzed in detail with respect to structural integrity and performance capability. Since these studies showed that the proposed design met performance objectives and the safety analyses indicated that the fuel containment objectives could be met under all forseeable accident conditions, a detailed program plan for developing the SLRV radioisotope power supply was prepared. (L.C.L.)

20208 (ORNL-EIS-72-18(Vol.1)) AN INVENTORY OF ENERGY RESEARCH. VOL. I. A Report Prepared for the National Science Foundation, Research Applied to National Needs (RANN). (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 641p. Dep. NTIS.

Approximately 4400 research projects are listed by title under one of 14 categories of energy sources. These categories are: fossil fuels, general; coal; petroleum; natural gas; nuclear, general; nuclear fission; nuclear fusion and plasmas; hydraulic; solar; geothermal; wind; wood and other biological; chemical; and unspecified energy source. Each of the 14 categories of energy sources is divided into eight stages for each source, starting with exploration, continuing through mining and extraction, concentration and refining, transportation, storage, conversion, distribution, and ending with use. Each of these eight stages is, in turn, subdivided into the six following fields of research: basic research; engineering development; economic; environmental; legislative/regulatory; and historical. (P.C.H.)

20209 (ORNL-EIS-72-18(Vol.2)) AN INVENTORY OF ENERGY RESEARCH. VOL. II. A Report Prepared for the National Science Foundation, Research Applied to National Needs (RANN). (Oak Ridge National Lab., Tenn.). Jan 1972. Contract W-7405-eng-26. 338p. Dep. NTIS.

Indexes for the approximately 4400 projects listed in Volume I are given. Indexes are included for: research institution; sponsoring agency; principal investigator; and permuted index of titles. (P.C.H.)

20210 (TID-5573) DYNAMIC CONTROL STUDY AND SIMULATION OF A ONE-HALF KILOWATT MERCURY POWER CONVERSION UNIT. Leovic, Wm. J.; Mueller, Milton, W.; Deibel, D. L. (Thompson Products, Inc., Cleveland, Ohio). 7 May 1958. 130p. (ER-3547). Dep. NTIS.

A system for converting high-temperature mercury vapor into usable electric power was studied to determine the influence of the various transients that will be imposed on the system and the control systems needed to reduce or eliminate these transient effects so that the power conversion system can function properly. Major components of the system considered are: a radioisotope-fueled boiler for producing the Hg vapor; Hg vapor turbine; turbine driven alternator; Hg vapor condenser; subcooler; boiler, bearing and electrical cooling pump; and the control system for providing overall regulation and stability. Information is included on: system specifications; minimum control requirements; ideal controls for the basic system; realistic control approach; and control system selected for fabrication and test. (L.C.L.)

20211 (TID-25901) TBC-1 POST INITIAL TEST EVALUATION REPORT. (RCA, Harrison, N. J.). 1 Oct 1971. Contract AT(29-2)-2831. 35p. Dep. NTIS.

For General Electric Co., Philadelphia, Pa. Space Div.

Thermal vacuum testing of TBC-1 demonstrated good power performance at 715 and 935°C hot shoe temperatures, but provided 91% of predicted power at 1035°C. During operation of TBC-1, a single-point short was detected which by itself would not account for the power loss. Upon return to room temperature and removal of the shell, heavy black, electrically conductive deposits were observed to be randomly distributed on the cold side of the thermopile. This was significant because a distributed short in combination with the single-point short could result in a converter power loss. To determine the cause of the power loss, postulations of failure modes were made for the observed and other possible conditions. Tests and analyses in conjunction with detailed reviews of other data were performed to confirm or reject the postulated modes. It was concluded that the loss of power was due to the combination of a single-point short (cold side instrumentation in parallel rows 1 and 2) and a distributed short (carbonaceous and sodium deposits which bridged most of the cold stack alumina ceramics). The origin of the carbonaceous material was shown to be the graphite compliance pad used in the electrical heat source; the sodium came from the Norton cement used in the heat source. All attempted methods suitable for cleaning the ceramics in TBC-1 to increase the resistance to ground proved unsuccessful because the deposits penetrated the ceramics to depths of greater than 20 mils. Sodium is known to attack the glassy phase of alumina ceramics at the temperature of operation. Even if a suitable cleaning method could be achieved it would prove a fruitless labor because deposits are also present in the Astroquartz wrap around the unicouples and the Astroquartz spacers at the colder half of the thermopile and end cap foil insulation; these deposits may be expected to continue to vaporize and redeposit at the cold stacks during heat-up and operation of TBC-1. It is expected that about a 2% power loss would initially occur in the absence of a single-point short upon resumption of TBC-1 testing. However this may increase due to redeposition of the carbonaceous and sodium materials. (auth)

20212 THEORY OF INSTABILITY IN MHD CHANNELS. Valentini, Hans-Burkhard (Zentralinstitut fuer Elektronenphysik, Jena, Ger.). Pr. Inst. Masz. Przeply.; No. 54-55, 85-104(1971). (In German).

The mean current density and electric field strength in MHD channels, and hence the efficiency and power of MHD generators are affected by instabilities. These instabilities are of the ionization and magneto-acoustic type. For both types of instabilities basic equations are formulated and the conditions for the amplification are discussed on the basis of examples. Results of calculations using the generalized Ohm law of the mean values of the terms up to the second order in the amplitudes of the oscillations are included. The effective electrical conductivity, the effective Hall parameter, and mean electron temperature are determined on that basis. Instabilities decrease these quantities. A brief review of the literature dealing with the instabilities in MHD channels is also given. (auth)

20213 INVESTIGATION OF OPTIMUM CONDITIONS FOR ENERGY CONVERSION IN MHD GENERATOR. Zaporovskii, Boleslav (Instytut Nowych Zrodel Energii Politechniki, Poznan, Poland). Pr. Inst. Masz. Przeply.; No. 54-55, 77-84(1971). (In Russian).

Results of investigations of the efficiency of heat conversion into electric energy in the MHD generator as a function of initial energy parameters of the plasma are presented. Values of the energy parameters and physical properties of the plasma obtained by combustion of conventional fuels in the oxidizer with variable O_2-content, and its variable physical enthalpy are given. The losses of energy in cooling the combustion chamber and duct as well as in introducing the ionizing seed are taken into account. An analysis of the effects of energy variations in the plasma on the output from the duct is presented. A description is included of the MHD generator having a thermal power of 4 MW, by means of which the analysis was experimentally verified. (auth)

20214 INFLUENCE OF PHYSICO-CHEMICAL PROPERTIES AND TEMPERATURE OF ELECTRODES ON FORMATION OF LAYERS NEAR THE ELECTRODES IN THE MHD GENERATOR DUCT. Mitkowski, Eugeniusz; Kordus, Aleksander (Instytut Nowych Zrodel Energii Politechniki, Poznan, Poland). Pr. Inst. Masz. Przeply.; No. 54-55, 69-76(1971). (In German).

Phenomena associated with the formation of boundary layers in the duct of the MHD generator and the effects of physicochemical properties, and that of the temperature of electrodes, on the size of these layers are discussed. Theoretical analysis determining the effects of the value of electron work functions and that of the electrode surface temperature on the value of the potential drop near the cathode has been confirmed by calculations. Results of experimental investigations of MHD generators fed with combustion products using potassium seed and electrodes made of graphite with added metals of low work function are also analyzed. (auth)

20215 THERMODYNAMIC PROPERTIES OF LIQUID METAL MHD POWER CYCLES. Bayer, Zdenek (Czechoslovak Academy Sciences, Prague). Pr. Inst. Masz. Przeply.; No. 54-55, 47-57 (1971).

Results of an analysis of a liquid metal MHD cycle with multistage condensing injector are presented. It was found that one-fluid systems cannot be considered favorable because of their low thermal efficiency. The two-component Li-K system seems to be the most convenient of all for practical application. The multistage arrangement of condensing sections proved to be advantageous, particularly in systems with relatively a low grade of cycle reversibility. The two-stage arrangement can be regarded as generally suitable while the systems with more stages have to be examined very carefully. The analysis of the multistage arrangement together with the previous conclusion concerning the working fluid preheating have led to the disclosure that the susceptibility of thermal efficiency of liquid metal MHD cycles to the working fluid properties decreases rapidly with the cycle's reversibility. This finding confirms the general thermodynamic consideration and can serve as a basis for further improvement of these cycles. The concept itself is in the initial stage of its development, and the ideas regarding its possibilities in the field are not clear. Other important questions to be settled

stem from the nature of the problem: the energy conversion takes place in the region of exceedingly wet vapor, i.e., in a region not thoroughly investigated experimentally. Any success in this direction will undoubtedly have a bearing on further progress of MHD systems and will be of considerable general significance as well. (auth)

20216 APPLICATION OF ROZHDESTVENSKII'S HOOK METHOD TO THE INVESTIGATION OF AN MHD GENERATOR. Shukhtin, A. M.; Kozlov, Yu. G.; Plekhotkin, G. A.; Reshetov, E. P.; Flid, B. D. (Leningrad State Univ. Inst. of High Temperatures, Moscow). Dokl. Akad. Nauk SSSR; 200: No. 3, 579-80(21 Sep 1971). (In Russian).

Working with the products of combustion of natural gas in an air–oxygen mixture, an alcoholic solution of NaI was injected into the combustion chamber, and an interference pattern was observed in the region of the yellow Na doublet. An interferogram was obtained with a slightly distorted pattern, from which the concentration of Na in the normal state could be confidently determined. (K.S.W.)

Facilities and Equipment

20217 (AECL–4073) FLUID MECHANICAL ANALYSIS OF AXISYMMETRIC FACE SEALS ON THE BASIS OF CONSTANT VISCOSITY, LAMINAR FLOW. Metcalfe, R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Dec 1971. 29p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

Conventional mechanical face seals are discussed, and proposed theories of operation are reviewed. The fluid mechanics of thin films, as applied to face seals, are described. Analytical expressions for performance are derived, based on assumptions of axisymmetric, constant viscosity, laminar flow through a radially non-uniform gap between seal faces. A two-point fit to a power function is used to approximate the gap. The four major face seal performance parameters, leakage, viscous heat generation, axial stiffness and minimum face separation are analyzed. For a particular seal it is shown that knowledge of one of these now enables all others to be calculated. Close correlation of analysis with experiment is shown to be obtained. Face separations, calculated from measured leakage in eight tests, give a mean agreement of about 11% with those calculated from measured heat generation. Optimum design of face seals is investigated on the basis of this analysis. Analytical results are presented graphically in non-dimensional form. These enable leakage and axial stiffness to be optimized for a particular seal design. (auth)

20218 (ALO–2683-1(Suppl.)) DEVELOPMENT OF A 600° CENTIGRADE HEAT PIPE ASSEMBLY. Supplement to Final Technical Report. (RCA Corp., Lancaster, Pa.). 30 Oct 1971. Contract AT(29-2)-2683. 43p. (TL–317-82-994-99(Suppl.)). Dep. NTIS.

A nickel heat pipe concept using potassium as the working fluid was developed for use with radioisotope heat sources. An important feature of the concept is a reservoir section pressurized with argon, which is located above the condenser and acts to contract the condensing region of the pipe as the power level of the heat source decays. The methods for and results from life testing three of these heat pipes to 6,000, 10,000, and 41,000 hours are described. (L.C.L.)

20219 (BNL–50146) IRRADIATOR DESIGN CALCULATIONAL TECHNIQUES BASED ON CENTERLINE DEPTH DOSE DISTRIBUTIONS. Rizzo, F. X. (Brookhaven National Lab., Upton, N. Y.). Nov 1968. Contract AT(30-1)-16. 17p. Dep. NTIS.

Quick, easy, and reasonably accurate methods are presented for calculation of dose distributions in irradiators. The methods are intended for use with data that deal with depth dose distributions and uniformity ratios for typical irradiator geometries and targets. Calculations are given for 3 examples. (M.C.G.)

20220 (CONF-710938–, pp 29-30) HEAT PIPE AT LOS ALAMOS. Kemme, J. E. (Los Alamos Scientific Lab., N. Mex.). 1971.

From eleventh international conference on thermal conductivity: Albuquerque, N. Mex. (28 Sep 1971).

20221 (LF–44, pp 1-6) DESIGN AND PERFORMANCE OF THE LOVELACE AEROSOL PARTICLE SEPARATOR. Kotrappa, P.; Light, M. E. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The Lovelace Aerosol Particle Separator (LAPS) provides a continuous separation of aerosol particles in the micrometer and submicrometer size ranges according to their aerodynamic equivalent diameters. This new device uses the principle of centrifugal separation of particles in a spinning spiral duct. The LAPS is essentially a spinning rotor driven by a motor at a desired constant speed. An aerosol sample, drawn into an expanding spiral duct through an inlet at the axis of the rotor, is entrained in a laminar stream of clean air and drawn by negative pressure through the channel. The particles are deposited according to their aerodynamic diameters along a 46.2 cm-long collection foil lining the outer wall of the spiral duct, and the very small particles are collected on a filter at the exit end of the spiral, thereby providing a continuous separation of aerosol particles in the entire size range of interest. The device is relatively inexpensive, rugged, easy to operate and can be driven either by an induction-type household motor or by a more elaborate centrifuge drive. It is suitable for separating aerosol particles for a variety of purposes including analysis of aerodynamic particle size distribution, preparation of monodisperse particles, measurement of densities of spherical aerosol particles, and measurement of particle shape factors. Because of its centrifugal properties, the separator has no loading limitations or wall losses. This allows it to be used as a standardizing device for other aerodynamic samplers such as cascade impactors. (auth)

20222 (ORNL–TM–3439) SEALS FOR REMOTE INSTALLATION IN A V-BAND TYPE CLAMPED FLANGE. Abbatiello, A. A.; Fraas, A. P.; Scott, R. L. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 33p. Dep. NTIS.

Various seals for remote installation in the HFIR HB-1 beam hole flange were tested. The original seal (an annealed aluminum Conoseal gasket) developed a leak owing to unusual circumstances and needed replacement. The activity around the beam hole precluded any changes to the flange halves already installed on the reactor vessel or to the beam tube, thus limiting modification to the gasket materials and geometry. Several gasket forms were tested with demineralized water at 1000 to 1500 psi (the normal operating pressure is 650 psi). Various flaws were simulated on the gasket or flange surfaces and the sealing ability of each gasket was evaluated. Applicable gasket types for this service are recommended based on the test results. (auth)

20223 (PWAC–152) RADIATOR DESIGN EVALUATION. Carey, W. T. (Ferrotherm Co., Cleveland, Ohio). Dec 1955. 139p. Dep. NTIS.

For Pratt and Whitney Aircraft, East Hartford, Conn.

Two types of heat transfer surfaces were optimized for an air-cooled liquid metal radiator based upon performance and weight evaluation parameters. The waisted strip fin shows the best performance; and the waisted pin fin, the lowest weight and the highest degree of compactness. An engine radiator was designed for evaluation of the strip fin and pin fin surfaces. The strip fin has the lowest pressure drops for low effectiveness designs: the pin fin has the lowest weight and is required for high effectiveness designs. A pin fin radiator was designed for testing at Pratt & Whitney Aircraft. (auth)

20224 (PWAC-F–75-1) DESIGN CRITERIA FOR A POWER PLANT TEST FACILITY. Hedden, D.; Miles, W. L. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 1 May 1957. 55p. Dep. NTIS.

The complete design criteria for a facility capable of testing a nuclear aircraft power plant consisting of a single 300 MW reactor coupled to six JTN-9 turbo-jet engines were developed. The facility and supporting services are designed to handle a 300 MW solid fuel reactor (SFR) or a 300 MW circulating fuel reactor (CFR). Although it is possible that the first power plant to be tested may utilize fewer than six engines, the facility has been designed for six in keeping with the philosophy of maximum flexibility for future development. The facility will be designed to permit test operation for a maximum of 1000 h. However, during the first two years of operation the duration of a single power plant test will probably be of the order of 50 h. The facility consists of a structure approximately 275 ft × 125 ft divided into three sections; the service building, test cell, and support building. Descriptions are given of: the solid fuel reactor and circulating fuel reactor; the handling and transport equipment required in the test facility; the service, test cell, and support buildings; and all auxiliary equipment for instrumentation, control, ventilation, off-gas system, and waste heat disposal. (L.C.L.)

20225 (TID–5601) SUPPLEMENT TO VALVES AND THROTTLING DEVICES USED FOR MOLTEN SODIUM. SURVEY OF PERFORMANCE. Technical Report No. 1. Cotterman, F. D.; Black, W. S. (Corwith Co., Chicago, Ill.). 20 Apr 1959. Contract AT(11-1)-679. 9p. Dep. NTIS.

Performance data are presented for seven valves used with high-temperature liquid sodium in reactor systems. (L.C.L.)

20226 DEVICE FOR WATER SEPARATION. (to Licentia Patent-Verwaltungs GmbH). British Patent 1,259,901. 12 Jan 1972. Priority date 11 Oct 1968, Germany.

A crossover pipe between stages of steam turbines operated with wet steam is described which incorporates a water separating device comprising a plurality of tubes the axes of which are generally parallel to the part of the pipe in which they are located. Each tube contains a co-axially disposed hub provided with vanes to produce rotary steam flow and guide ribs to produce a water separating effect. An agglomerator is provided to enlarge the water droplets. The device achieves satisfactory water separation with small losses of steam and pressure. (J.R.D.)

20227 MEASUREMENT OF THE PENETRATION OF HIGH EFFICIENCY FILTERS USED IN AIR DECONTAMINATION SYSTEMS. Cagnetti, P. (CNEN–CSN, Casaccia, Rome). Minerva Fisiconucl.; 14: No. 4, 172-81(Oct-Dec 1970). (In Italian).

The use of high-efficiency filters in the inlet air system of work areas in nuclear plants and for purifying contaminated gaseous effluents is discussed. Measurements made for several years in the U.S.A. on such filters showed that often the retention efficiency values guaranteed were not fulfilled. Since in the majority of cases it was necessary to know as precisely as possible the concentrations of radionuclides in the gaseous effluents, the nuclear commissions of several countries have developed various methods for controlling the characteristics of high-efficiency filters. The same type of activity is being developed at Casaccia. The first part of the present study is devoted to the examination of the problem from the general viewpoint. The preliminary results are reported. (tr-auth)

20228 OUT-OF-PILE TEST RIGS. Dixon, J. A. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Int.; 17: No. 189, 106-7(Feb 1972).

A brief description is given of the main out-of-pile test equipment built up by the UKAEA for studying problems such as heat transfer, pressure drop, vibration, acoustic effects, corrosion, and tribological aspects in water, gas, and sodium environments. (UK)

Heat Transfer and Fluid Flow

Refer also to abstracts 20217, 20218, 20220, 20223, 20258, 20544, 20886, 22207, and 22342.

20229 (AE-RL-1258) MEASUREMENT OF VOID FRACTION WITH AN IMPEDANCE VOID METER. Panella, Bruno (Aktiebolaget Atomenergi, Studsvik (Sweden)). 10 Nov 1970. 32p. (SDS-7). Dep. NTIS (U. S. Sales Only).

In a study aimed at determining the mass flow rate and enthalpy distribution in a rod bundle, a measurement technique has been investigated based upon the correlation between the void fraction and the electrical impedance of a two-phase mixture. The impedance is measured by a cylindrical probe connected to a Wheatstone bridge. The electrical signal is registered on an oscilloscope. The calibration has been performed with air and water at atmospheric pressure in a plexiglass loop, comparing probes of two different shapes. Measurements with steam at different pressures have been carried out in the loop Hilxan with the probe mounted in a round test section. Study has been made of a modified probe for measuring the void fraction in a rod bundle. (auth) (Sweden)

20230 (AE-RL-1301) TWO-PHASE FLOW IN A NINE-ROD BUNDLE WITH TILTED POWER DISTRIBUTION. Gustafsson, Bernt; Kjellen, Boerje (Aktiebolaget Atomenergi, Studsvik (Sweden)). 19 May 1971. 36p. (SDS-20). Dep. NTIS (U. S. Sales Only).

Research on two-phase flow in a 9-rod, square array, test section, which is 1.5 m high, and has a very high radial power gradient, is described. The power generated is zero in the rods of the first line, 0.9 in the second line and 2.1 in the third. Descriptions are given of the experimental equipment and techniques. The test section is supplied with flow split, γ-void attenuation meter, film flow sucking-off device, and resistance void needles. Results are given from runs in separate loops during the development of the water film, γ-void, and void needle meters. (auth) (Sweden)

20231 (AECL-4126) TEMPERATURE TRANSIENTS IN A CYLINDER DUE TO A TIME VARYING HEAT TRANSFER COEFFICIENT. Blair, J. M.; Selander, W. N. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jan 1972. 24p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

Two methods are presented for solving the one-dimensional heat equation in a heated cylinder cooled by forced convection when the heat transfer coefficient is changing with time. These methods may be used to predict the temperature transients in a fuel rod following a pump failure or some other disturbance in the coolant system. The first method, which involves the solution of an integral equation with a singular kernel, also provides an error estimate of the computed temperatures. The second method reduces to the solution of an ordinary differential equation and is convenient for numerical computation. Both methods apply to an arbitrarily varying heat transfer coefficient. The results are illustrated for the case of a linear variation with time. (auth)

20232 (COO-2152-2) INVESTIGATION OF PRESSURE DROPS AND HEAT TRANSFER COEFFICIENTS FOR LOSS OF COOLANT EVALUATIONS. Quarterly Progress Report for Period Ending December 31, 1971. (Cincinnati Univ., Ohio. Dept. of Chemical and Nuclear Engineering). Contract AT(11-1)-2152. 6p. Dep. NTIS.

Progress in assembling equipment and developing experimental procedures for investigating the pressure drop and heat transfer phenomena which occur during a loss-of-coolant accident is reported. Three major experiments are planned and include: transient pressure drop investigation; two-phase pressure drop and flow pattern study; and transition boiling and reflooding heat transfer tests. (L.C.L.)

20233 (NP-19194) MEASUREMENTS OF VOID FRACTION IN ACTUAL AND SIMULATED TWO-PHASE FLOW CONDITIONS USING A GAMMA-RAY ATTENUATION VOID METER GAUGE. Staiti, Sergio (Aktiebolaget Atomenergi, Studsvik (Sweden)). Sep 1971. 37p. (AE-RL-1313; SDS-25). Dep. NTIS (U. S. Sales Only).

This work was carried out in connection with the 9-rod bundle experiment, where a γ-ray attenuation method for void fraction determination was employed. Measurements were taken on modified reduced-scale test sections, in order to select the most suitable operating conditions for a specially designed γ-ray void meter, and to test its effectiveness. Experiments were run with air and water at atmospheric pressure in a plexiglass loop. A scintillation crystal-photomultiplier tube assembly was chosen to detect a narrow γ-ray beam passing through a simulated flow subchannel of a square array 9-rod bundle. The output from the detector was correlated with successive flow conditions, i.e., with the channel empty, filled with water, and containing various air-water mixtures, and the results were compared with analytical data. The principal errors inherent in the method, and in the present test facilities, were also analyzed and evaluated. Two ^{137}Cs sources with different activities (0.5 mC and 50 mC) were used in the investigations. At a later stage, experiments were also carried out with lucite mock-ups simulating different void conditions in a shortened 1:1-scale 9-rod bundle. Within the envisaged purposes, the results appear to be fairly satisfactory. Further tests and more refined test facilities seem to be needed. (auth) (Sweden)

20234 (RLO-2227-T-4-3) EXPERIMENTAL STUDY OF NATURAL CONVECTION HEAT TRANSFER FROM VERTICAL FLAT PLATES IN MERCURY. Welty, James R.; White, Donald H. (Oregon State Univ., Corvallis. Dept. of Mechanical and Nuclear Engineering). [nd]. 2p. Dep. NTIS.

Experiments were performed to study the natural convection heat transfer from vertical flat plates in mercury. The temperature and velocity profiles for different positions along the plate were simultaneously measured by a probe containing a hot-film anemometer and thermocouples. Tests were made for Grashof numbers of 4×10^7 and 9×10^8 for a constant heat flux plate and for 2×10^7 and 8×10^7 for the pseudo-constant temperature plate. The measured results were compared with analytically predicted results. It was concluded that present analytical models do a poor job of predicting velocity profiles and only a fair job of predicting temperature profiles, and that natural convection heat transfer rates in liquid metals are higher than predicted by the present analytical models. (L.C.L.)

20235 (STU-70-407/U-338) TWO-PHASE FLOW IN A NINE-ROD BUNDLE WITH TILTED POWER DISTRIBUTION AND FLOW-SPLIT IN THE OUTLET. Gustafsson, Bernt (Aktiebolaget Atomenergi, Studsvik (Sweden)). Sep 1971. 5p. (In Swedish). Dep. NTIS (U. S. Sales Only).

To improve understanding of the thermohydraulic parameters which determine the heat transfer in rod bundles, a 9-rod, square array, test section was built. In the outlet of the test section there is a flow split device where the flow is divided into four parts. By this means it is possible to calculate the coolant mass and enthalpy distribution for subchannels. The test section is supplied with pressure taps for measuring both axial and radial pressure gradients. A water film suck-off device is arranged on the rods and

needles are mounted in the subchannels for flow regime measurements. The equipment for γ-void and resistance void measurements requires further calibration and will not be used in the first period of measurements. The project is supported by the Swedish Board for Technical Development and the report consists of a very brief status report in Swedish, three reports in English (AE-RL--1301, AE-RL--1313, AE-RL--1258), and minutes in Swedish from a committee meeting for the Scandinavian subchannel analysis cooperative project. (F.H.S.) (Sweden)

20236 THEORETICAL ESTIMATES ON THE ELECTRICALLY IONIZED STRIATED PLASMA FLOW. Milewski, Jerzy (Instytut Maszyn Przeplywowych, Danzig). Pr. Inst. Masz. Przeply.; No. 54-55, 105-15(1971).

Results of approximate theoretical analysis of the physical parameters of conducting zones of gases in striated flows consisting of electrically conducting portions separated by nonconducting portions are presented. The analysis is directed to estimating values of flow parameters, the electric power required for sustaining flow, and to determining the conditions required for stable flow. (J.R.D.)

20237 METHOD OF CONTINUOUS MONITORING OF THE ENTRAINED GAS CONTENT IN A SODIUM FLOW. Baum, M. R. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 1, 59-64(Jan 1972).

The use of the phenomena of choking in two-phase flow as a void fraction meter is considered. Tests, performed with H_2O-A and H_2O-N_2 flows, are described which demonstrate the operation of a choked nozzle as a gas detector. Application to a fast reactor is examined. It is concluded that continuous monitoring of entrained gas content in a sodium flow based on a choking phenomena in gas-liquid bubble flow in a convergent-divergent nozzle appears feasible. For Na at 300°C void fractions of the order of 10^{-3} appear detectable with a stagnation pressure of 270 kN/m^2. This may be reduced to 10^{-4} or less by use of a bubble collecting device (UK)

20238 MULTIREGION ANALYSIS OF THE EFFECT OF ROD DISPLACEMENT ON HEAT TRANSFER IN SLUG FLOW THROUGH CLOSELY PACKED ROD BUNDLES. Hsu, Chia-jung (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 47: No. 3, 380-8(Mar 1972).

The heat transfer characteristics of a rod which is dislocated from its symmetrical position are studied analytically for slug flow through tightly packed rod bundles (P/D ratio down to ≈1.00). Explicit equations describing the temperature fields in the fuel core, the cladding, and the elemental coolant flow area are obtained by assuming uniform fuel power density. Variation of the rod-average Nusselt number, as well as the heat flux distribution at the outer wall of the cladding, is examined for selected values of σ, the P/D ratio, the cladding thickness parameter, $\lambda(=r_1/r_2)$ and the thermal conductivity ratios, κ and κ_w. The present solutions, when specialized to the case of σ = 0.0 (i.e., no rod displacement) show excellent agreement with the results reported by Axford and by Dwyer and Berry who studied the corresponding three-region and two-region problems, respectively, for symmetrical rod bundles with no rod displacement. (auth)

20239 EXPERIMENTAL STUDY OF HEAT TRANSFER TO LIQUID METALS FLOWING IN-LINE THROUGH TUBE BUNDLES AT A CONSTANT AND EXPONENTIAL HEAT FLUX DISTRIBUTION. Graeber, H.; Rieger, M. (EURATOM, Ispra, Italy). Atomkernenergie; 19: No. 1, 23-40(Feb 1972). (In German).

For the determination of the relation Nu = f(Pe, p/d, F_0) valid for liquid metals between the Nusselt number Nu, the Péclet number Pe, the pitch-to-diameter ratio p/d and the parameter F_0 describing the influence of the axial distribution of the heat flux density $q_w \propto \exp(mx/d_h)$ an extensive experimental study has been carried out. In three pairs of test sections with 31 tubes of d = 12 mm OD arranged in an equilateral triangular lattice of p/d = 1.25, 1.60, or 1.95 both the temperatures of the tube walls and those of the fluid (NaK-44/56) in the center of various subchannels were measured by means of about 80 thermocouples per test section. For the realization of constant heat flux density q_w = const.; F_0 = 1 three test sections were built as heaters, the 31 tubes and the shell heated electrically. In three more test sections working as heat exchangers and set up in a "figure-8" arrangement exponentially varying distributions of the heat flux density $q_w \propto \exp(mx/d_h)$; $F_0 \neq 1$ were studied. The experimental results for constant heat flux density satisfy the equation $Nu = a + b\,Pe^c$ with the coefficients a = 0.25 + 6.20 p/d, b = −0.007 + 0.032 p/d and c = 0.800 − 0.024 p/d. The test series studying the influence of the parameter F_0 on the Nusselt number confirm the predictions. (auth)

Materials Testing

Refer also to abstracts 19927, 20549, 22375, 22401, and 22412.

20240 (CONF-710445) RADIOGRAPHY DAY, STUDSVIK, SWEDEN, 27 APRIL 1971. (Aktiebolaget Atomenergi, Studsvik (Sweden). Ingenjorsvetenskapsakademien, Stockholm (Sweden). Tekniska Rontgencentralen A. B., Stockholm (Sweden)). 109p. (In Swedish). (AES-9; IVA-35).

Nine papers on radiographic methods for detecting and characterizing defects in materials were presented at the conference. A separate abstract was prepared for each of 2 papers. Seven papers were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 20241 and 20242.

20241 (CONF-710445-, pp 69-89) MICROTRON USED IN HIGH-VOLTAGE RADIOGRAPHY. Oesterberg, Jan (Tekniska Rontgencentralen A. B., Stockholm (Sweden)). (In Swedish).

From Radiography day conference; Studsvik, Sweden (27 Apr 1971).

A microtron giving 8-MeV electrons was constructed for radiography of thick castings. The x-ray intensity at 1 m is 1500 R/min giving exposing times of 5 sec for 100 m Fe and 15 min for 300 mm Fe. (J.K.) (Sweden)

20242 (CONF-710445-, pp 90-102) NEUTRON RADIOGRAPHY: A NEW METHOD FOR NONDESTRUCTIVE TESTING. Sokolowski, E.; Gustafsson, I. (Aktiebolaget Atomenergi, Studsvik (Sweden)). (In Swedish).

From Radiography day conference; Studsvik, Sweden (27 Apr 1971).

The principles and techniques involved in neutron radiography are reviewed. The radiograph at the R2-0 reactor in Studsvik is described. Examples are given of neutron radiograms of irradiated and non irradiated fuel elements, of fuel elements with burnable poison and of partly hydrated zircaloy tubes. (J.K.) (Sweden)

20243 (ORNL-TM-3712) THICKNESS MEASUREMENTS USING EDDY-CURRENT TECHNIQUES. Dodd, C. V.; Simpson, W. A. Jr. (Oak Ridge National Lab., Tenn.). Mar 1972. Contract W-7405-eng-26. 33p. Dep. NTIS.

Eddy currents have been used for many years to measure the thickness of a single conductor and the thickness of one conductor clad on another. By performing a computer analysis of the problem, the optimum conditions for performing such measurements were chosen. Effects of varying thickness, frequency, coil size, conductivity, lift-off (or coil-to-conductor spacing), and coil resistance are discussed. The use of a phase-sensitive eddy-current instrument in performing thickness and clad thickness measurements is emphasized. (auth)

20244 (Y-1808) ULTRASONIC DATA ANALYSIS USING A COMPUTER. Sachs, R. D.; Elkins, J. D., Smith, J. H. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 22 Feb 1972. Contract W-7405-eng-26. 18p. Dep. NTIS.

A digital computer is used to analyze the data obtained from the ultrasonic inspection of a weld. The computer is interfaced to a standard ultrasonic flaw detector and to the scanning mechanism. The computer can automatically determine the size of a flaw and its location on the test part as the test is being conducted semiautomatically. (auth)

20245 NONDESTRUCTIVE TESTING OF WELDED JOINTS OF VESSELS AND PIPING IN NUCLEAR TECHNOLOGY. Trumpfheller, R. Schweissen Schneiden; 23: No. 4, 138-40(1971). (In German).

The nondestructive testing of welded seams represents a significant part of the construction costs of nuclear plants. The strictest specifications concern the reactor pressure vessels because here all possibilities for failure detection are used, even if the probability of special failure types is low. For the description of technical testing specifications for welded seam testing on pressure vessels, the concept of complete ultrasonic testing has been defined. The required testing sensitivity is established by means of arbitrary errors. For the evaluation of failure statements it is essential to recognize systematic defects. The austenitic weld plating provided for at the inner wall of pressure vessels and heat exchangers of water-cooled reactors requires additional testing. (INIS)

20246 HYPERVELOCITY IMPACT INVESTIGATION WITH PHOTOELASTIC TECHNIQUES. Honnold, V. R. (TRW Systems Group, Redondo Beach, Calif.). pp 105-17 of Applied Mechanics Aspects of Nuclear Effects in Materials. /Wan, Conrad C. (ed.). New York; American Society of Mechanical Engineers (1971).

From Meeting on applied mechanics aspects of nuclear effects in materials; Washington, D. C. (2 Dec 1971).

The technique of dynamic photoelasticity has been applied to a study of hypervelocity impact phenomena. The target consisted of a front plate of cadmium followed either by a void or a foam-filled space, and a rear plate of steel or aluminum. Two series of tests were carried out. The first, employing a Plexiglas rod acting as a Hopkinson pressure bar in a transmission polariscope arrangement, sensed the stagnation pressure time history resulting from debris impact in the second plate. In the second series, the rear plate was provided with a photoelastic coating and became the subject of interest in a reflection polariscope arrangement. Dynamic stress patterns, produced by debris impact, were photographed as they developed in time and provided a whole field view of the nature of the pattern. The experimental results indicated that Plexiglas can be used successfully in a photoelastic version of Hopkinson pressure bar for dynamic stress measurements in the range of several kilobars. Dynamic plate motion as revealed by the reflection polariscope showed the presence of elastic extensional waves accompanying second plate deformation and rupture. (auth)

20247 METHOD OF CHARACTERISTIC CALCULATION OF ENERGY DEPOSITION AND IMPACT PROBLEMS. Chou, Pei Chi; Tuckmantel, Donald (Drexel Univ., Philadelphia). pp 118-41 of Applied Mechanics Aspects of Nuclear Effects in Materials. /Wan, Conrad C. (ed.). New York; American Society of Mechanical Engineers (1971).

From Meeting on applied mechanics aspects of nuclear effects in materials; Washington, D. C. (2 Dec 1971).

One-dimensional impact and energy deposition problems are solved numerically by method of characteristic computer codes. Results are compared with those calculated by finite-difference codes. For the problems studied, the finite-difference codes yield peak pressures that are below those calculated by the method of characteristics code. (auth)

20248 CONSTITUTIVE EQUATIONS FOR COMPACTION OF POROUS MATERIALS. Herrmann, Walter (Sandia Labs., Albuquerque, N. Mex.). pp 142-68 of Applied Mechanics Aspects of Nuclear Effects in Materials. /Wan, Conrad C. (ed.). New York; American Society of Mechanical Engineers (1971).

From Meeting on applied mechanics aspects of nuclear effects in materials; Washington, D. C. (2 Dec 1971).

Porous materials are widely used for shock attenuation. Many structural materials are porous as a result of their manufacturing process. In order to analyze the response of porous materials to high velocity impacts, explosions, or intense transient radiation, an adequate constitutive equation describing material response is needed. Attempts to construct such constitutive equations are reviewed. Topics covered include very high pressure response where thermodynamic considerations predominate, low stress responses where a purely mechanical theory is adequate, and a combination of thermodynamic and mechanical theories. Remarks are also made concerning rate-dependence of pore collapse, and the extension of the theory to general triaxial stress states. (auth)

20249 THERMOVISCOELASTIC MATERIAL RESPONSE TO DYNAMIC LOADS. Cost, Thomas L. (Univ. of Alabama, University). pp 169-200 of Applied Mechanics Aspects of Nuclear Effects in Materials. /Wan, Conrad C. (ed.). New York; American Society of Mechanical Engineers (1971).

From Meeting on applied mechanics aspects of nuclear effects in materials; Washington, D. C. (2 Dec 1971).

The problems associated with the loads induced by nuclear effects in engineering structures composed of thermoviscoelastic materials are reviewed and the response of such materials to stress wave loadings described. The attenuative and dispersive nature of viscoelastic materials is illustrated by examples. The temperature dependence of the viscoelastic properties is described and a computational device discussed which is capable of computing the effect of temperature dependent viscoelastic properties in layered structures. Theoretical bases for current computational methods are also reviewed. (auth)

20250 EQUIPMENT FOR GAMMA RADIOGRAPHY OF CLOSED VESSELS AND PIPELINES. Stein, Stephen. U. S. Patent 3,633,032. 4 Jan 1972. Filed 21 Apr 1969.

A container for a radioactive source comprises a cylindrical two-part shield, one part being fixed and the other part movable axially with the source being located along the axis midway between the two parts of the shield when in the open position. Springs act to hold the two parts together in the closed position and a time-controlled actuating mechanism separates the two parts of the shield against the spring action for a set period of time (Official Gazette)

20251 ALTERNATE FORM OF THE RAMBERG–OSGOOD FORMULA FOR MATRIX DISPLACEMENT ANALYSIS. Venkateswara Rao, G.; Krishna Murty, A. V. (Indian Inst. of Science, Bangalore). Nucl. Eng. Des.; 17: No. 3, 297-308(1971).

A new stress-strain law, which is a three parameter representation of stress in terms of strain has been proposed for the matrix displacement analysis of structures made of non-hookean materials. This formula has been utilized to study three typical problems. These studies brought out the effectiveness and suitability of this law for matrix displacement analysis. (auth)

20252 REVIEW ON RADIOGRAPHIC INSPECTION IN 1970. Senda, Tomio (Osaka Univ., Suita, Japan). Hihakai Kensa; 20: No. 7, 341-3(Jul 1971). (In Japanese).

Radiographic inspection status in 1970 is reported for standards, equipment, and inspection methods. In addition to Japan Industrial Standards (JIS) for steel and aluminum welds, standards for stainless steel welds and for radiographic testing of aluminum welds have been submitted. As the adaptation of radiographic testing expands, linear accelerators and betatrons are being developed for use with thicker objects, while utilization of gamma source of ^{170}Tm is being investigated for thinner samples. In order to establish radiographic conditions, penetrometer identification has been investigated. A practical method using radiation quality gages is also discussed. Authorizing examinations for nondestructive testing engineers has been conducted smoothly and resulted in many qualification certifications. (Japan)

20253 STRESSES IN THE VICINITY OF AN ELLIPTIC HOLE IN A CYLINDRICAL SHELL UNDER TORSIONAL LOADING. Bapu Rao, M. N.; Murthy, M. V. V. (National Aeronautical Lab., Bangalore, India). Nucl. Eng. Des.; 17: No. 3, 309-21(1971).

A perturbation solution is presented for the stresses around a small elliptic hole in an infinitely long circular cylindrical shell subjected to torsion. The major axis of the hole is taken to be parallel to the shell axis. For the limiting case of a crack, the general solutions in elliptic coordinates are expanded at the crack tip in polar coordinates to obtain stresses in the form usual to solutions for crack problems. (auth)

20254 RECTANGULAR FINITE ELEMENT FOR PLATE BENDING ANALYSIS BASED ON HELLINGER–REISSNER'S VARIATIONAL PRINCIPLE. Kikuchi, Fumio; Ando, Yoshio (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 28-35(Jan 1972).

Based on Hellinger–Reissner's variational principle, a rectangular finite element for plate bending is derived with bilinearly varying deflection and incompletely linear moments. This is an example of the mixed method first proposed by Herrmann, where both displacement and stress are adopted simultaneously as fundamental variables. Because continuity conditions required on the fundamental variables are much relaxed compared with compatible models, suitable shape functions can be easily derived and calculation of the element matrix can be performed by hand. The explicit expression of the element matrix for general orthotropic plates is presented. A few simple test problems are computed in order to demonstrate the accuracy of the model, and it is shown that it gives improved results compared with Herrmann's triangular element. Convergence is also assured when suitably small mesh sizes are adopted, and this element can be utilized in general practical problems. (auth)

20255 ANALYSIS OF ISOTOPE RADIOMETRIC DENSITY ERRORS FOR THIN SECTIONS OF MATERIALS. Schultz, Arnold W. (Avco Corp., Lowell, Mass.). Mater. Eval.; 30: No. 2, 39-43; 48(Feb 1972).

An analysis of the contributing errors is essential when attempting to perform radiometric density measurements to a precision of 1% and better, especially for materials having thicknesses ranging between 10 and 250 mils. A mathematical treatment is presented which provides a tool for optimizing the measurements. It serves as a guide for selecting source energy and intensity, as well as the minimum counts required to achieve precision results for thin materials having a complex chemistry. An illustrative example of the use of a parametric minimum counts graph is included. The application of this treatment to thin multicomponent materials, such as the newer fiber-reinforced composites, is described. (auth)

20256 NEUTRON RADIOGRAPHY DEVELOPMENT USING RESEARCH REACTORS. Barton, J. P. (Oregon State Univ., Corvallis). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 13(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

20257 NEUTRON RADIOGRAPHY IN INDUSTRY. Tomlinson, R. L. (Aerotest Operations, San Ramon, Calif.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 14(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

20258 FRAMEWORK FOR RADIOGRAPHIC AND FLUIDIC NEUTRON TRANSMISSION ANALYSIS. Harms, A. A. (McMaster Univ., Hamilton, Ont.); Garside, B. K.; Hancox, W. T. Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 14-15(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

20259 NEUTRON RADIOGRAPHY WITH ^{252}Cf: A LONG WAY WITH A SMALL SOURCE. Cason, John L. (Gamma Industries, Baton Rouge, La.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 15-16(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

20260 APPARATUS FOR FATIGUE TESTS ON FINE WIRE. Geminov, V. N.; Kop'ev, I. M. (Inst. of Metallurgy, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 6, 932-3(Jun 1971).

Translated from Zavod. Lab.; 37: No. 6, 729-30(Jun 1971).

The design and operation of an apparatus for fatigue testing of fine, 0.10 mm-dia or less, wire are described. The specimen is situated in a triangular cross section groove inscribed in a plate along an arc of a circle. This plate is covered by a second plate to restrain the wire in the groove. The wire, in its fixed arc, is fixed at one end and attached at the other end by a hypodermic needle to the rotating shaft of a drive motor. The wire tested is connected to an electrical circuit which switches off the motor when the wire breaks, and the number of motor rotations before failure are automatically counted. This testing device is simple in construction, permits testing of relatively long lengths, 20 to 30 mm, of fine wire, and provides constant test conditions which improve the reliability of the results. Fatigue tests data for three specimens of Mo wire are presented. (L.C.L.)

Nuclear Explosions

Refer also to abstracts 20326, 20327, 20343–20346, 20348, and 20350.

20261 (STI/PUB-298) PEACEFUL NUCLEAR EXPLOSIONS. II. THEIR PRACTICAL APPLICATION. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, 18–22 January 1971. (International Atomic Energy Agency, Vienna (Austria)). Nov 1971. 363p. (In several languages). (CONF-710108). IAEA $10.00.

Twenty papers were presented before the panel. A separate abstract was prepared for each of nineteen papers. One paper was previously abstracted in NSA as 25: 51664. (J.R.D.)

For abstracts of individual papers see: 20268–20286.

20262 (TID-25931) BANEBERRY SUMMARY REPORT. (Atomic Energy Commission, Washington, D. C.). May 1971. 17p. Dep. NTIS.

The Baneberry underground nuclear device development test of less than 20 kilotons was detonated near the northern border of Yucca Flat on the Nevada Test Site (NTS) at 7:30 a.m., PST, on December 18, 1970. All programmed operations proceeded normally until 3.5 minutes after detonation when a release of radioactivity commenced from a fissure which opened up after detonation at a distance of about 300 feet and in a southwesterly direction from the emplacement hole. This release continued over an extended period even after commonly experienced surface collapse occurred at 16.5 minutes after detonation. The effluent venting rate steadily decreased with time but visible vapor continued to emanate from the fissure for 24 hours after detonation. The events surrounding the Baneberry release and postshot investigative findings and conclusions are reported. The Baneberry venting can be attributed basically to stronger coupling of energy into the ground than is normal for tests buried at this depth in Yucca Flat. This stronger coupling was due to a high water content at shallow depth which resulted from a geologic environment unique in test experience and limited to a relatively small area around the Baneberry site. The emplacement geometry and other geologic characteristics of the surrounding media may have contributed in a lesser degree to the release. Radioactivity released as a result of the Baneberry detonation produced some exposures to personnel both onsite and offsite. However, operational safety procedures instituted following the detonation were successful in ensuring that radiation exposures to test site workers or the offsite population were below currently established Federal Radiation Council standards for normal peacetime operations. The radiological safety activities associated with Baneberry are reviewed. On the basis of the Baneberry experience and investigation, the USAEC took the following actions to strengthen technical and administrative procedures to substantially reduce the probability of a similar future occurrence: more extensive geologic and geophysical investigations; the institution of more conservative area controls and restriction of forward area personnel and facilities to minimum requirements; and a more vigorous analytical program so as to better understand the behavior of nuclear detonations in the various environments which may be encountered in emplacing underground tests, with special emphasis on more conservative burial depth for low-yield experiments. (auth)

20263 (UCRL-51171) FRENCH–AMERICAN TECHNICAL EXCHANGE OF GEOLOGIC INFORMATION RELATED TO PEACEFUL USES OF NUCLEAR EXPLOSIVES. Stephens, D. R. (California Univ., Livermore. Lawrence Livermore Lab.). 11 Jan 1972. Contract W-7405-eng-48. 21p. Dep. NTIS.

The French–American technical exchange of geologic information related to peaceful uses of nuclear explosives was held in Berkeley, California, from October 26 to 29, 1971. Topics discussed included rock sample selection and testing, numerical calculations, field data collection and interpretation, and geochemical data and interpretation. The results of the 13 French underground detonations in Hoggar granite were extensively discussed along with the U. S. Piledriver, Gasbuggy, and proposed Wagon Wheel experiments. Reports and new information were exchanged; the French furnished Hoggar granite samples to the U. S. for study and the U. S. gave Wagon Wheel sandstone samples to the French for examination. The meeting participants concluded that another meeting would be beneficial to each country's program. At which time the U. S. would discuss the Hoggar granite results and the French their Wagon Wheel studies. (auth)

20264 LINEAR MODEL FOR THE YIELD DEPENDENCE OF MAGNITUDES MEASURED BY A SEISMOGRAPHIC NETWORK. Ericsson, Ulf (Research Inst. of National Defense, Stockholm). Geophys. J. Roy. Astron. Soc.; 25: No. 1-3, 49-69(Dec 1971).

The connection between the yields of six underground nuclear explosions in the Pahute Mesa in Nevada and the body and surface wave magnitudes measured at 19 Canadian seismographic stations is described by a simple statistical model. It describes the expected magnitudes as linear functions of the logarithm of the yield and attributes the apparently normally distributed magnitude variations between stations to wave path dependent level differences between the transfer functions from the source area to the stations. The model assigns the same scaling exponent for yield to all stations. The exponent is, however, larger for surface wave magnitudes than for body wave magnitudes. The station residuals are partly attributed to differences, between explosions, in the energy coupling in the source area. The residuals are roughly normally distributed and the stations can be divided into groups with high and low residual variances. Applications of the model to the prediction of station magnitudes from given yields, to the calculation of maximum likelihood estimates of yields from measured station magnitudes and to the identification of underground nuclear explosions by simultaneous measurements of body and surface wave magnitudes are briefly discussed. (auth)

Civil Uses

Refer also to abstract 20334.

20265 (NP-19183) ECONOMICS OF STIMULATING NATURAL GAS RESERVOIRS WITH NUCLEAR EXPLOSIVES. (Atomic Industrial Forum, Inc., New York). Nov 1970. 48p. Atomic Industrial Forum, Inc., New York $6.00.

Engineering and economic considerations associated with all gas wells and the unique advantages and problems inherent with nuclear stimulation are summarized. A review is made of the cost structure of recent experimental nuclear stimulation tests and projections are made on how these costs might change for "routine" applications. The concept of the time value of money and discounting future revenues for present day worth was used in arriving at an economic evaluation. By making assumptions about the amounts of gas-in-place and the probable production after stimulation, investments that will yield a specified percent return are calculated. These guideline investment limits are presented in a series of tables and graphs designed for representative tight gas reservoirs in the Rocky Mountain area. The tables and graphs include parameters of desired before-tax rate of return on investment, percent gas recovery over twenty years, and wellhead gas price. Industry and government groups contemplating the production of gas from Rocky Mountain reservoirs can utilize the tables and graphs for estimates of allowable investments per square mile of reservoir. In most Rocky Mountain applications it appears that total cost for nuclear stimulation projects, including drilling, must be less than one million dollars per square mile when several hundred vertical feet of

reservoir are stimulated. If several thousand feet of vertical section are available and can be stimulated, then investments of several million dollars per square mile may be commercially acceptable to industry. This is based on wellhead price range of fifteen to twenty five cents per MCF. (auth)

20266 (NVO–1163–231) OBSERVED SEISMIC DATA MINIATA EVENT. A PLOWSHARE DEVELOPMENT TEST. Spiker, C. T.; Christie, R. K. (Environmental Research Corp., Las Vegas, Nev.). Feb 1972. Contract AT(29-2)-1163. 53p. Dep. NTIS.

Results of processing the observed ground motion data for the Miniata Event, an underground nuclear detonation on Yucca Flat, at the United States Atomic Energy Commission's Nevada Test Site are reported. Ground motion data recorded at instrument stations deployed by the Earth Sciences Laboratory were processed by Environmental Research Corporation. Pseudo-Relative Velocity Spectra at 5% damping were derived from the velocity seismograms. (auth)

20267 (UCRL–51163) POSSIBLE EFFECTS OF THE RIO BLANCO PROJECT ON THE OVERLYING OIL SHALE AND MINERAL DEPOSITS. Holzer, F.; Emerson, D. O. (California Univ., Livermore. Lawrence Livermore Lab.). 27 Dec 1971. Contract W-7405-eng-48. 28p. (PNE-RB–8). Dep. NTIS.

The proposed Rio Blanco nuclear detonation for stimulating natural gas production (and the subsequent development of the Rio Blanco Unit) has raised questions about possible harmful effects of the explosions on the overlying formations containing oil and sodium minerals. It is shown that fractures will extend to perhaps 400 ft above the upper explosive. Since at least 2300 ft separates the gas-bearing strata from the oil shale and minerals, no fractures will extend into the formations containing these resources. A spall depth of about 170 ft was calculated. Experience indicates that no harmful effects will occur as a result of this spall. It is expected that subsurface separation of the rock layers in the Green River Formation will not occur. A seismic reflection survey shows that the closest indication of a subsurface fault occurs about 2 miles from the Rio Blanco location. Data from the Nevada Test Site show that no fault farther than 6000 ft from a 100-kt explosion would undergo explosion-induced displacements, and hence none is expected from Rio Blanco. At the mine closest to Rio Blanco, a peak acceleration of 0.06 g is predicted. Since this is about the same acceleration experienced by this mine from the Rulison explosion, Rio Blanco should not cause any mine damage. (auth)

20268 STATEMENTS ON NATIONAL PROGRAMS. pp 1-19 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971). (In several languages).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB–298; CONF-710108.

Summaries of national programs devoted to peaceful uses of nuclear explosives are presented. Statements by representatives from Australia, France, India, USSR, UK, and USA are included. (J.R.D.)

20269 RULSION: UNDERGROUND ENGINEERING EXPLOSIVE AND EMPLACEMENT CONSIDERATIONS. Aamodt, L. (Los Alamos Scientific Lab., N. Mex.). pp 61-83 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB–298; CONF-710108.

Two nuclear explosives have been detonated in low permeability natural gas reservoirs in sparsely populated regions in western USA. For the Rulison event the methods used to emplace the device and contain the radioactivity generated in the explosion, together with those for regaining access to the stimulated gas, were not optimized. Simpler and more efficient methods are required for attaining these objectives. Criteria for safe emplacement and improved methods of satisfying these criteria are discussed. (auth)

20270 CONCEPTS OF NATURAL GAS FIELD DEVELOPMENT WITH NUCLEAR EXPLOSIVES. Frank, G. W. (Austral Oil Co., Houston, Tex.). pp 85-104 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB–298; CONF-710108.

Two natural gas reservoir stimulation experiments conducted in the United States of America have led to certain large-scale reservoir development concepts at an early time in the research and development stage of the United States Plowshare Program. The Rulison Field of Garfield County, Colorado, USA, the site of the most recent experiment, is a typical natural gas reservoir that is amenable to development with nuclear explosives. The depth range of the natural gas bearing rock is sufficient to accommodate considerably higher yield explosives than will be used for development. The thickness of the reservoir requires multiple explosive emplacement in the same borehole for efficient fracturing. Although fairly remote, the development of the Rulison Field will require special consideration of yield and proximity to population areas in order to minimize the nuisance aspect. Well over 100 wells could be drilled and stimulated in the Rulison Field, with allowances for topography, population and structures. The initial rate of development will be dependent upon the deliverability of gas required by the gas purchaser, and the ability of the producer to obtain suitable gas prices. Simultaneous drilling and preparation of multiple holes will be considered. Sequential firing of the explosives over a period of hours will minimize the cost of the required safety programs and the overall support of the nuclear operations. Total field development could require several years to complete. Surface handling facilities will be an integral part of the development program, including the construction of a plant to recover ethane, propane, butanes and heavier hydrocarbons. Radiation safety measures should be simple and routine, as should confirming seismic data and environmental surveillance efforts. (auth)

20271 COMPLETELY CONTAINED NUCLEAR EXPLOSIONS AS A MEANS OF INCREASING OIL PRODUCTION. Kedrovskii, O. L. (State Committee on the Utilization of Atomic Energy, Moscow). pp 105-114 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971). (In Russian).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB–298; CONF-710108.

Descriptions are given of test explosions carried out in an inhomogeneous carbonaceous reservoir belonging to one of the oil fields. These explosions, one with a yield of approximately 8 kt and two with a yield of 2.3 kt each, were designed to provide information and to confirm the possibility of intensifying the working of the field. Data are given on the geological structure of the test area, the increase in oil extraction after the explosions and the absence of any complications due to contamination of the oil by radioactive products. Investigation results indicate the possibility of achieving substantial increases in production and a reduction in exploitation periods. Promising systems for intensifying the exploitation of oil and natural gas fields with the help of underground nuclear explosions are reviewed. (auth)

20272 ENSURING RADIATION SAFETY IN CONNECTION WITH COMPLETELY CONTAINED NUCLEAR EXPLOSIONS. Kedrovskii, O. L. (State Committee on the Utilization of Atomic Energy, Moscow). pp 115-26 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971). (In Russian).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB–298; CONF-710108.

The conditions which give rise to radiation hazards in connection with fully contained nuclear explosions are examined. The minimum charge depth which will ensure that the explosion can be carried out in safety is determined. A set of radiation safety measures is discussed. A description is given of a method for remote and continuous recording of the gamma-radiation dose from radioactive gases in the cavity and in producing wells, which can be used where explosions are carried out in gas and oil fields. The results of investigations into the nature of oil contamination after an underground nuclear explosion are presented. Experimental work in the laboratory and in the field has shown that nuclear explosions can be safely carried out in oil-field reservoirs. (auth)

20273 INDUSTRIAL APPLICATION OF NUCLEAR EXPLOSIVE ENGINEERING TECHNOLOGY TO NATURAL GAS RESERVOIRS. Smith, S. (El Paso Natural Gas Co., Tex.). pp 127-37 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB–298; CONF-710108.

Utilization of nuclear explosive natural gas reservoir stimulation technology in a competitive fuel market must ultimately satisfy one of two types of economic justification to be considered prudent. The first is that it must result in adequately efficient production from very low permeability natural gas reservoirs to financially sustain such operations when conventional well completion techniques have proven uneconomical. The second would be the application of this technique in conventionally productive areas where the increase in daily deliverability could result in lower unit production costs. In the United States current experimental efforts are being directed toward the sub-marginally productive, low permeability areas and it is expected that this technology will be refined in the context of such operations. There are several reasons for this approach. Increasing demand for natural gas assures a ready market for any new natural gas production. As a result, those areas in which economic operation can be dem-

onstrated will be rapidly developed through conventional practices. Nuclear explosive design optimization for contained underground engineering applications would be expected to occur during the course of experimentation in such low permeability natural gas reservoirs. Lastly, legislative authorization governing the availability of nuclear explosives for industrial use is currently limited to research and development or demonstration type applications, as opposed to commercial utilization. A significant element in the development of nuclear explosive gas stimulation technology will be refinement of reservoir rock analysis techniques and improved understanding of the productive capacity of very low permeability reservoirs. (auth)

20274 STORAGE OF NATURAL GAS IN CAVITIES CREATED BY UNDERGROUND NUCLEAR EXPLOSIONS. Parker, K. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 139-65 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

The use of natural gas by the energy and chemical industries is increasing in many parts of the world. Many countries face the problem of developing a secure and efficient supply and distribution system for natural gas. Even in compact geographical areas it is advantageous to provide a variety of storage facilities against the possibility of interruptions in supply and as an aid in meeting the peak demand most economically. Technically, storage in cavities created by underground nuclear explosions is one possible way to meet this need. A theoretical study is made to estimate the likely cost of storing natural gas in such cavities forming part of a typical Western European gas distribution system in order that the relative costs of several methods of natural gas storage can be compared. The technical and economic problems which arise will be of interest in many other areas since a basic principle of natural gas storage is that it should be sited close to points where the gas is consumed: it appears that the acceptability and cost of seismic damage will dominate the appraisal of underground storage schemes involving nuclear explosives. The main technical problems relate to the purging of radioactivity from the rubble-filled storage chimney and to the integrity of the completed storage system. (auth)

20275 GAS STORAGE APPLICATION OF PNE. Randolph, P. L. (El Paso Natural Gas Co., Tex.). pp 167-81 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

The value of underground storage for natural gas is strongly dependent upon location in relationship to source of supply, pipelines and the market, as well as dependent upon market fluctuations and judgment regarding need for improved reliability of supply. The cost of creating storage is similarly dependent upon local geology and nuclear yield limitations to avoid creating unacceptable ground motion effects upon structures. In 1969 the El Paso Natural Gas Company transmission system in the southwestern United States delivered a daily average of 3.8×10^9 ft^3 of natural gas from 51,000 wells to customers. In 1966 it was recognized that underground storage in a 15,000 mile^2 area of western Arizona with a peak deliverability of 2.5×10^9 ft^3/d could be competitive with the average cost of $62.5 million to expand the system capacity by that amount. The geologic and nuclear effects investigations are described which have revealed a massive salt deposit in a location where five 200 kiloton nuclear detonations at a depth 5600 ft can provide this storage at an estimated cost of $20 million. (auth)

20276 EUROPEAN GAS STORAGE: THE APPLICATION OF NUCLEAR EXPLOSIVES. van der Harst, L. (CER Geonuclear Corp., Las Vegas, Nev.). pp 183-200 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

Underground nuclear explosions in impervious rock media create cylindrical, rubble-filled caverns, or chimneys, which may be used to provide storage space for liquids or gases. The average permeability of such chimneys is of the order of millions of darcies and, as a result, the deliverability rates are limited only by the dimensions of wells and surface installations as well as the pipeline input pressures. Natural gas has recently been introduced as an important energy source in Europe and usage rates are increasing faster than in the United States of America. The major sources are located in the northeastern Netherlands, the North Sea, southern France, and Russia. A large transmission network is being built to deliver gas to the major market areas; however, storage systems near user areas are required for efficient pipeline utilization. Although the need for large-scale gas storage is obvious, the use of nuclear explosives to create underground storage has not been widely considered before for several reasons. In the first place the technique is relatively new and is not common knowledge among utility engineers. Then the high population density of Europe has been mentioned as a reason for not investigating this application further. The seismic problems involved in nuclear storage projects are discussed and several areas which, from a demographic standpoint, appear amenable to such projects are suggested. The various advantages of nuclear storage over other underground storage methods are examined. The economics as well as procedures and time schedules for the execution of a generalized nuclear gas storage project are also discussed. (auth)

20277 INVESTIGATION OF COMPLETELY CONTAINED NUCLEAR EXPLOSIONS IN ROCK SALT WITH A VIEW TO DEVELOPING TECHNIQUES FOR THE CREATION OF UNDERGROUND STORAGE CAVITIES. Myasnikov, K. V. (Inst. of Applied Geophysics, Moscow). pp 201-8 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971). (In Russian).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

Nuclear explosions offer a promising means of creating underground storage space in rock salt. The problems involved in developing the requisite technology are reviewed. A description is given of the results of two nuclear explosions in rock salt (yields 1.1 and 25 kt) which solved some of the outstanding technological problems. The conclusion is reached that further investigations will be needed before the method can be exploited for industrial purposes. (auth)

20278 COMPLETELY CONTAINED NUCLEAR EXPLOSIONS AS A MEANS OF STOPPING UNCONTROLLED OIL AND GAS FLOWS. Kedrovskii, O. L. (State Committee on the Utilization of Atomic Energy, Moscow). pp 209-22 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971). (In Russian).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

Aspects of the industrial application of completely contained nuclear explosions to stop complex gushers in gas fields are reviewed. A description is given of the most important conditions required for the effective use of explosions for eliminating gushers. The principal assumptions involved in calculations on the elimination of gushers and uncontrolled flows are presented, and the mechanism by which the explosion seals off the well is explained. The specific geological and engineering conditions that existed during the two fully contained nuclear explosions which sealed off the two wild wells and halted the gas gusher are described. (auth)

20279 OTHER UNDERGROUND APPLICATIONS OF PNE. Nordyke, M. D. (Univ. of California, Livermore). pp 223-32 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

The use of nuclear explosives to prepare ore for underground in situ leaching appears to be one of the most economically attractive applications which, as yet, has not been evaluated by a field test. A number of modes of leaching are possible (e.g., acid leaching of secondary ores at the surface with retorts or in completely contained chimneys) and a wide variety of minerals appear amenable (e.g., copper, molybdenum, nickel, uranium). The method receiving most intensive study at the present time is the chemical mining of primary copper ores below the water table using pressurized oxygen at elevated temperatures. Two other applications under study that appear to have significant environmental advantages over competing systems are the use of nuclear explosives to fracture the rock in geothermal reservoirs for the recovery of the thermal energy contained therein and the use of nuclear explosions to create storage volumes for disposal of radioactive wastes from nuclear reactor fuel-element reprocessing plants. (auth)

20280 CURRENT PRACTICES AND ANTICIPATED IMPROVEMENTS IN PNE. Thornbrough, A. D. (Atomic Energy Commission, Las Vegas, Nev.). pp 235-52 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

Current practices in the peaceful uses of nuclear explosions are based upon using single detonations. Predictions of ground motion are made based upon the yield, depth of the explosion and geologic investigations. These ground motion predictions are

used to assess the effects on man-made and natural structures and to estimate the costs of the projected damage. Steps leading to the relatively accurate prediction of seismic effects in project Rulison are outlined, and an empirical cost relationship is shown. Operational procedures are being developed to utilize the simultaneous or sequential detonation of nuclear explosives in one vertical array and to detonate several of these arrays in a short period of time (one day). These techniques are expected to optimize the fracturing effects, reduce the seismic motions, reduce the inconvenience to the public and provide the maximum benefit. Increased understanding of the many parameters will be required. Recent data from a simplified firing system is described and administrative requirements for commercial application are itemized. (auth)

20281 MECHANICAL EFFECTS OF A CONTAINED NUCLEAR EXPLOSION. Ferrieux, H.; Guerrini, C. (CEA, Bruyeres-le-Chatel, France). pp 253-73 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971). (In French).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

The 120 kt Monique shot was carried out in the granite massif of Tan Afella (Sahara). The ground movements caused by the explosion were recorded at distances ranging from a few meters to some 50 km. The propagation of the shock wave was followed over this entire distance. Recordings of various types were made during the experiment (measurements of shock-wave arrival time, acceleration, velocity, and material displaced; the pressure was recorded by an indirect method). These different parameters were checked against the general experimental patterns established for the whole series of contained explosions in the Sahara. The changes in the environment and the damage associated with the Monique explosion were studied by means of several types of measurement effected after the shot. (auth)

20282 EXPLOSION SEISMOLOGY. Thirlaway, H. I. S. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 275-81 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

Underground nuclear explosions provide an excellent source of seismic signals by which the interior of the earth can be studied. A significant amount of experience and information in this regard has been gained in the past 25 years from such explosions. In comparison with earthquakes, nuclear explosions are much more useful since all the fundamental parameters of the source, including the source mechanism, can be precisely measured and the source and the signal receiver locations can be arranged to optimize the experimental design. Of prime interest is the detailed mapping of lateral variations within the first 500 km or so of the earth's surface as it is in this layer that the processes responsible for earthquakes and volcanoes, the earth's surface features and the concentration of mineral resources are taking place. To take full advantage of the signal, a network of some 40 to 50 standardized receiving stations within a radius of 2000 km is essential. The costs of fielding and operating such an array are discussed. (auth)

20283 SPREAD OF RADIOACTIVE PRODUCTS IN THE FRACTURED-ROCK ZONE RESULTING FROM A COMPLETELY CONTAINED NUCLEAR EXPLOSION: CALCULATION OF POSSIBLE CONTAMINATION OF OIL THROUGH THE ATTEMPT TO INTENSIFY EXTRACTION BY MEANS OF NUCLEAR EXPLOSIONS. Izrael, Yu. A.; Pressman, A. Ya.; Bataev, K. G.; Stukin, E. D. (Inst. of Applied Geophysics, Moscow). pp 283-93 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971). (In Russian).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

The distribution of volatile radioactive products or products having gaseous precursors in rock shattered by a completely contained nuclear explosion is described. The number of such isotopes in the fracture zone and the rubble-filled chimney depends to a large extent on the time taken for the cavity to collapse. A possible pattern of contamination of the oil by radioactive isotopes is suggested and the rate of arrival of these products with the oil at the producing wells in the region of the explosion is indicated. The calculated strontium-89 and cesium-137 concentrations in the oil show good agreement with experimental data. (auth)

20284 RADIOACTIVITY RELEASED BY NUCLEAR EXPLOSIONS. Stewart, K. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 295-303 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

The potential hazard from the radioactivity which accompanies nuclear explosions is examined and a basis for the reasonable and safe application of such explosives to peaceful purposes is described. The radioactivity may be liable to accompany the product to be extracted from the earth or it may enter the local environment directly so that fully adequate controls must be introduced to protect any local population which could be adversely affected. It is essential to assess the risk dispassionately and rationally, bearing in mind our limited knowledge on the effects of small radiation doses over extended periods of time. The question of permissible levels of radiation will need very careful consideration and should be related to the recommendations of the ICRP rather than to arbitrarily chosen numerical values. On present evidence it seems that nuclear explosives can be used safely for peaceful purposes but each case has to be studied separately before judgement can be given. (auth)

20285 METHOD FOR ESTIMATING THE RISK FROM A PLOWSHARE DETONATION. Otway, H. J. (Los Alamos Scientific Lab., N. Mex.). pp 305-18 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

A method is presented for estimating the risk to the public from an underground Plowshare detonation, with a sample application to a hypothetical gas storage experiment. The probability of fission-product release as well as the frequencies of various wind and weather conditions are considered. The fission-product release versus probability relationships were determined by a statistical analysis of applicable Nevada Test Site data, using a multivariate discriminate analysis technique. These relationships may be applied to most Plowshare underground engineering applications with the exception of those in media having formation pressure, such as natural gas stimulation. Results of the sample application indicate that the risks to the public from a Plowshare detonation are very small and that consideration should be given to executing experiments without planning for specific weather conditions. (auth)

20286 RADIOLOGICAL SAFETY CONSIDERATIONS IN THE DISTRIBUTION OF NATURAL GAS THAT CONTAINS RADIONUCLIDES. Jacobs, D. G.; Struxness, E. G. (Oak Ridge National Lab., Tenn.). pp 319-39 of Peaceful Nuclear Explosions. II. Vienna; International Atomic Energy Agency (1971).

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971). See STI/PUB-298; CONF-710108.

Nuclear stimulation of natural gas reservoirs may result in detectable quantities of residual radionuclides becoming a part of the distributed products. Processing and diverse utilization of the gas and its by-products lead to numerous pathways of radiation exposure involving sizable population groups. A detailed assessment of potential radiation impact expressed on the basis of radiation dose should be made before the explosions occur, and the pertinent facts relating to these assessments should be reported in such a way that reasonable judgements can be made as to the risks and their acceptability. Initially, a simplified analysis can be used to give upper limit estimates for determining the feasibility of continued developmental efforts. Prior to the prototype utilization of products from a nuclearly stimulated well or storage cavity, a detailed assessment should be made based on engineering and demographic data. Such an assessment must be adequate to withstand critical review. The initial production from a prototype well should be monitored throughout the collection, processing, and distribution system to provide positive evidence that the calculated dilutions and dispositions in prior assessments are realistic and to obtain information for the design of a permanent monitoring system. Studies of Gasbuggy and Rulison results indicate that the radionuclide concentrations in the gas decrease as gas is produced and that the potential radiation doses from releases of combustion products to the atmosphere can be at least an order of magnitude lower than those from releases within a closed space. Radiation doses to members of the public can be minimized by limiting initial use to large central electric generating plants, or permitting unrestricted domestic use only if there is significant dilution in the distribution system. (auth)

20287 RADIATSIONNAYA BEZOPASNOST' PRI TEKHNICHESKIKH YADERNYKH VZRYVAKH. (Radiation Safety in Connection with Nuclear Detonations for Engineering Purposes). Krivokhatskii, A. S.; Katsapov, V. I. Moscow; Atomizdat (1971). 48p.

The use of nuclear explosions for engineering purposes is a relatively new trend in the exploitation of atomic energy on behalf of the national economy. An apparent economic advantage is coupled with the utilization of nuclear explosions for accomplishing the most daring projects which may not be realizable

with common explosives. The radioactive products, however, have potential dangers to human welfare; assurance to the population of the observance of radiation safety measures is therefore essential. Field tests of nuclear explosions are discussed as well as the planning, use of, and the accompanying radioactivity releases from such explosions. (K.S.W.)

20288 PEACEFUL NUCLEAR EXPLOSIONS: BEHIND THE BROUHAHA. McKnight, A. (Univ. of Sussex, Eng.). New Sci.; 53: No. 781, 256-8(3 Feb 1972).

Applications of peaceful nuclear explosions (PNE) are discussed and their technical attractions including the potential ability in civil engineering works and mineral development of breaking and moving, quickly and cheaply, large quantities of hard rock are considered. However, the accompanying effects are major and potentially deleterious. Unpredictability, production of radioactivity and its release to the atmosphere and to aquifers, fallout of debris, air blast, ground motion, and product contamination are discussed in relation to applications of PNE. The economics of such works are considered and the possible prejudicial effect on the quest for disarmament discussed. It is considered that there has been considerable overselling of PNE which has raised unfulfillable expectations in the developing countries. (UK)

Protective Structures and Equipment

20289 (CEA-N-1453) APPARATUS FOR SODIUM MELTING AND DISSOLUTION IN A SHIELDED CELL. Beraha, Robert; Duclos, Victor; Ilies, Etienne (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Aug 1971. 15p. (In French). Dep. NTIS (U. S. Sales Only).

An apparatus for the dissolution of sodium in a shielded cell is described. The advantage of the system is that it can process 10 to 20 grams of sodium in a minimum time and a minimum amount of aqueous solution. A brief survey of existing methods is followed by a description of the apparatus used and the method of operation. (France)

20290 (ORNL-TM-3562) MORE EFFICIENT OPERATION OF KEARNY AIR PUMPS FOR MANUAL VENTILATION OF SHELTERS. Kearny, Cresson H. (Oak Ridge National Lab., Tenn.). Sep 1971. 33p. Dep. NTIS.

The following developments and tests pertinent to more efficient design and operation of Kearny Air Pumps (KAP's) when used to ventilate and cool shelters are described: demonstration of the unreliability of a KAP when operated in the doorway of a dead-end shelter room; development and tests of a technique for using an A-Frame Kearny Air Pump to efficiently ventilate a dead-end shelter; development and tests of improved handles and bridles with which to pull especially 6-foot KAP's that must be pulled directly, without the help of a pulley attached above the operator(s); perfection of illustrated written instructions to enable average Americans to operate KAP's efficiently, when guided only by these written instructions; determination of the preference of average citizens for pulling a 6-foot KAP with its pull-cord connected 15 inches from its hinge line, as compared with its pull-cord connected 3 feet from its hinge line; improvement of the durability of the flaps for KAP's; and development of means for protecting homemade KAP's that are being operated inside shelters from being damaged by a moderate velocity shockwave and blastwind entering the shelter. (auth)

20291 (RT/PROT-(71)35) STUDY OF A HOT LABORATORY FOR EXPERIMENTS OF TREATMENT OF LIQUID RADIOACTIVE WASTES. Masotti, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 18 Oct 1971. 135p. (In Italian). Dep. NTIS (U. S. Sales Only).

A study concerning a hot laboratory for experiments on treatment of liquid radioactive wastes is described. Technical, economic, and operational aspects as well as safety and health protection of the facility were taken into consideration, bearing in mind the surrounding conditions. (auth)

20292 SHIELDING ABILITY OF SAFETY GLASSES IN FLUOROSCOPIC EXAMINATIONS. Maillie, H. D.; Jaspers, J. G.; Mermagen, H. (Univ. of Rochester, N. Y.). Health Phys.; 22: No. 1, 98-9(Jan 1972).

The scattering of x radiation during fluoroscopic procedures was duplicated in phantom experiments. Lithium fluoride dosemeters were taped two at a time on each eye and exposures measured with and without a pair of nonprescription safety glasses of the type currently dispensed by opticians. The x-ray machine used was a Maxitron Therapy Unit with a beryllium window and 2.5-mm Al placed in the beam, operating between 80 and 120 kVp. Each irradiation was delivered in a time estimated to give about 1R to the eyes. Glasses appeared to give a reduction of 0.60 to 0.68 of the incident scattered radiation and the use of side shields of pyrex glass gave a reduction of 0.55 to 0.63 of the incident scattered radiation. (UK)

20293 RADIATION DOSE TO THE SKIN AND BONE OF THE FINGERS FROM HANDLING RADIOISOTOPES IN A SYRINGE. Takaku, Y.; Kida, T. (Fukushima Medical Coll., Japan). Health Phys.; 22: No. 3, 295-7(Mar 1972).

Skin and bone doses to fingers from diagnostic amounts of ^{59}Fe, ^{131}I, ^{198}Au, and ^{203}Hg in shielded and unshielded plastic syringes were measured, and results compared with Clayton's (Am. J. Roentg. 105, 895(1969)). Decreases in the doses received by using syringe shields were also measured. Shielding was of lead or acrylite block. Lithium fluoride disc dosemeters were used for skin measurements and fluoroglass covered with acrylite for bone dose. Considerable variation was seen in the dose per 100 μCi-minute with radioisotopes and the thickness of syringe, as well as with Clayton's results. (UK)

20294 GORYACHIE I IZOTOPNYE LABORATORII. Vtoroe Izdanie, Pererabotannoe i Dopolnennoe. (Hot and Isotope Laboratories. Second Edition, Revised and Enlarged). Reformatskii, I. A. Moscow; Atomizdat (1971). 280p.

The organization, planning, and operation of hot laboratories, which utilize special shielding and remote-handling equipment used both in and outside of Russia, are discussed. The "norms for radiation safety" were revised to be consistent with the recommendations of the International Commission on Radiation Protection. Tables include radioisotope data and hazards, shielding data, and an outline of the larger hot laboratories of the world. 135 references. (K.S.W.)

Safety Engineering

Refer also to abstracts 20206, 20272, 20376, and 20377.

20295 (INIS-mf-158) RADIATION HEALTH AND SAFETY. Annual Report for the Year Ended 31st December 1970. Rosen, R. (New South Wales Univ., Kensington (Australia)). 1971. 17p. INIS.

All aspects of the work which concerned the New South Wales University's radiation office during 1970 are reviewed. Procedures involving the purchase and transfer of radiation sources are discussed and quantitaties of radioisotopes concerned are tabulated on a basis of allocation to research or teaching projects. Brief evaluations of personnel monitoring and associated services are made. (INIS)

20296 (ORO-3822-10) EFFECTS OF SOIL LIQUEFACTION ON LATERAL SEISMIC LOADS OF NUCLEAR POWER PLANTS. Raftopoulos, D. D.; Scavuzzo, R. J. (Toledo Univ., Ohio). Dec 1971. Contract AT(40-1)-3822. 33p. Dep. NTIS.

The effect of liquefaction of the soil on lateral soil-structure interaction is considered in this analysis. The maximum force F_D that can be developed between the soil and the structure is determined by multiplying a prescribed coefficient of friction f_0 times the total weight of the structure. The shear force f(t) at the base of the structure is determined by using the normal mode theory. This analysis is based on the assumption that the ground can be considered as a two-dimensional elastic half-space. A relative motion is found when the shear force f(t) at the base exerted by the structure exceeds the maximum force that the ground can resist by its frictional force F_D. A study of the response spectrum of the motion of the structure for various values of the coefficient of friction f_0 is presented herein and shows that the spectrum in the high-frequency range is affected significantly by both the relative sliding motion and the soil stiffness. (auth)

20297 (SC-M-710200) GUIDE TO PRESSURE SAFETY PRACTICES. (Sandia Labs., Albuquerque, N. Mex. Sandia Labs., Livermore, Calif.). 25 Jan 1972. 135p. Dep. NTIS.

This manual was adopted for use by all laboratories personnel. Design and operational requirements and recommended procedures are provided. Use of a Pressure Safety Analysis Report is specified, and several examples of reports are given. (auth)

20298 RADIATION PROTECTION IN THE PLANTS OF THE MINISTRY FOR THE MACHINE CONSTRUCTION INDUSTRY. Lapusan, Alexandru (Vulcan Plant, Bucharest); Stanescu, Ciceron, I.; Todea, Gheorghe. Constr. Masini; 23: No. 9, 560-6(Sep 1971). (In Rumanian).

The widespread industrial application of radiation sources, such as radioactive isotopes and x-ray machines made it necessary to consider closely the biological effect of radiations in order to protect the workers who might be exposed to them.

The energy of the most widely used radiations in industry ranges from 10^{-1} to 30 MeV. The concept of relative biological effectiveness is reviewed and the protective steps are outlined, explaining the calculation of industrial radiation shields. Conditions of work with radiation sources in Romania are subject to regulation promulgated in 1962 by the Nuclear Energy Committee; the pertinent control instruments, warning devices and personnel monitoring techniques are outlined. To illustrate the techniques involved, the organization of health physics surveys at the nondestructive testing and flow detection installations of the "Vulcan" plant is described. Five tables, 4 figures, no references. (JPRS)

20299 RADIATION PROTECTION IN RADIODIAGNOSTIC PRACTICE. Poch, R. (Karlova Univ., Prague). Prakt. Lek.; 51: No. 13, 497-9(5 Jul 1971). (In Czech).

Methods and equipment used for reducing the primary radiation intensity of x-ray tubes, and thus reducing the effect of harmful radiation on patients and medical personnel working in radiodiagnostic wards are reviewed. In addition to the use of adequate collimators and filters to homogenize the radiation, other means should be applied, such as x-ray image intensifiers, closed-circuit television, video-recorders, automatic exposure timers, etc. (INIS)

20300 RADIATION SAFETY IN MINE PASSAGES. Chesnokov, N. I.; Lebedev, Yu. A.; Pavlov, I. V. At. Energ. (USSR); 32: No. 2, 111-14(Feb 1972). (In Russian).

A method of calculating air contamination in mine passages due to the main source of radiation i.e., short-lived radon decay products is described. The proposed method makes it possible to calculate the required capacity of the ventilation system. Under conditions of severe air contamination at the air-intake, the air should be cleaned by forcing it through several filtering beds of lavsan fiber and FP fabric. The change in radon concentration and latent alpha particles when the ventilator is shut off is considered. It is shown that with a proper ventilation system the radiation safety problem can be successfully solved. (auth)

Vacuum Engineering

Refer also to abstract 20525.

20301 (UCRL-Trans-10585) NEW LOW TEMPERATURE GETTER: TITANIUM MONOXIDE. Prevot, F.; Sledziewski, Z.; Roquessalane, R. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Vide; 25: No. 145, 1-6(Jan.-Feb 1970). 15p. Dep. NTIS.

The activity coefficient and capacity of thin films of titanium and titanium monoxide under high vacuum and ultrahigh vacuum were measured. For air at room temperature titanium films and titanium monoxide films were practically equivalent as a getter, at low temperature, however, titanium monoxide films were better than pure titanium films. For air at low temperature the activity coefficient was as high as 1 and the capacity was over 4×10^{16} molecules/cm^2. At the temperature of liquid nitrogen argon was well pumped by titanium monoxide films: activity coefficient can reach 0.17 and capacity 10^{16} argon atoms/cm^2. (auth)

20302 ULTRAHIGH VACUUM (10^{-13} mm Hg) THROUGH CONDENSATION PUMPS. Grishin, S. F.; Grishina, E. Ya.; Chernyshenko, V. Ya.; Kovalenko, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1193-6(Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1519-24(Jul 1971).

Results of investigations are presented showing that in a vacuum chamber all the walls of which are at liquid-helium temperature, pressures of less than 10^{-15} mm Hg can be obtained. It has been shown experimentally that when large quantities of hydrogen are admitted to the chamber the limiting vacuum of the condensation pump does not differ from the vapor pressure of the substance being pumped at the temperature of the condensing surface. A bakable unit with condensation pumps has been constructed, in which a vacuum of 2×10^{-13} mm Hg has been obtained in a working volume of 100 liters and with the walls at room temperature. Mass-spectrographic analysis of the residual gases was carried out. It was shown that the residual gas is mainly hydrogen, the content of which determines the value of the achievable vacuum. Because of the low consumption of cryogenic liquids, the equipment is convenient to operate and can be recommended for use by organizations which do not possess their own cryogenic plants (if the delivery of relatively small quantities of refrigerants can be arranged). (auth)

20303 HYDROGEN PUMPING WITH A HELIUM-CONDENSATION PUMP AT ULTRAHIGH VACUUMS. Grishin, S. F.; Grishina, E. Ya.; Kovalenko, V. A.; Chernyshenko, V. Ya. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 7, 1197-8 (Jan 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 7, 1525-7(Jul 1971).

When large quantities of hydrogen are present on parts of a system, particularly on the gages, a so-called surface phase of hydrogen (chemically adsorbed layers) can develop. Therefore, when hydrogen is pumped with a helium-condensation pump the gage can read a higher pressure than the hydrogen-vapor pressure at the temperature of the condensing surface. The minimum pressure which can be reached decreases when the surface phase is removed. In a 100-liter system (without cold shields), pressures of about 10^{-10} mm Hg are obtained by pumping with a helium-condensation pump ($T_{cond} \approx 2°K$), a vacuum corresponding to 100 cm^3 hydrogen under standard conditions. (auth)

ENVIRONMENTAL AND EARTH SCIENCES

20304 ENVIRONMENTAL POLLUTION. A Guide to Current Research. New York; CCM Information Corporation (1971). 855p. $29.95.

Research projects are described in the volume under subject areas such as ecological systems, physical sciences applied to pollution, effects of pollution, air and water pollution, and causes of pollution. (J.R.D.)

Minerals and Ores

20305 URANIUM MARKET. Gimstedt, Olle (Atomic Power Group, Stockholm). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 85, 5-10(Sep-Oct 1970). (In French). (CONF-700903-19).

From fourth Foratom Congress on industrial aspects of the nuclear fuel cycle in Europe; Stockholm, Sweden (21 Sep 1970).

The present demand on uranium and the likely increases in these demands over the next fifteen years were studied. The production capacities were examined and the fact that present day production is only partially utilized is emphasized. The most recent world research is reviewed. Problems of cost, price trends, and financing are analyzed. (France)

20306 SEDIMENTOLOGY AND URANIUM PROSPECTING. Gabelman, John W. (Atomic Energy Commission, Washington, D. C.). Sediment. Geol.; 6: No. 3, 145-86(Oct 1971).

The world's principal economic uranium resources occur in continental sandstones or conglomerates often associated with preferred sedimentary structures. These relations have long been recognized and used empirically in exploration. Although the genesis of the uranium and the controls over its fixation are still debated, the epigenetic nature of deposits in sandstone is now generally accepted, and the argument has shifted to whether it is intrinsic or extrinsic to its present environment. In reducing oxygen-poor magmas and pegmatitic or hypothermal fluids, uranium enters into complex, refractory multiple oxides. It is more easily leached from volcanic glasses, but is not commonly available from any syngenetic source without corrosive alteration. Once liberated, uranium oxidizes readily and is mobile in the surficial environment. Reducing conditions in shallow, cool environments will stabilize uranium. It also may be stabilized in oxidized form by complexing with P, V, or As, or by loss of water in arid climates. Upon rock destruction, unaltered refractory minerals commonly remain intact to form placers. Liberated uranium is oxidized and dispersed in the fluid medium. It is extracted chiefly by ionic substitution or absorption in marine phosphates, and by adsorption on organic matter in carbonaceous shales. Both processes prevail everywhere during sedimentation of these uniform rocks, and uranium remains dispersed. It is rarely mobilized from these rocks because the chemical reducing environment remains so widespread. For economic deposits uranium must be concentrated from a mobilized dispersed state or introduced in concentrations. Epigenetic uranium migrates in fluid media through permeability systems that govern the quantity delivered to a precipitation site. Concentrations developed only where permeable rocks offered a precipitation mechanism. Altered rock matrices of most districts suggest that mineralizing fluids pervaded large blocks of ground, but formed deposits only in a few selected stratigraphic units under optimum combinations of permeability, host rock precipitants, and structures with interrupted permeability which allow the precipitants time to act. The most favorable structures are paleostream channels, intraformational unconformities of sandstone lenses in mudstone (or vice versa), and crossbeds. The sedimentary environment of each major productive formation in the United States is discussed, ranging from Triassic to late Tertiary. In each stratum only a small portion of the area of regionally similar sedimentational environment is mineralized. Only a few of the similar widespread sedimentary structures contain uranium, with no apparent differences between productive and barren examples. A common denominator of uranium districts within favorable host units appears to be the similarity in their tectonic position. (auth)

20307 IT CANNOT CONTINUE ON THE URANIUM MARKET. AN INTERVIEW WITH MR. R. W. WRIGHT, DEPUTY DIRECTOR OF THE RIO TINTO-ZINC CORP., LONDON. Atomwirt., Atomtech.; 17: No. 1, 20-2(Jan 1972). (In German).

A press interview with Mr. R. W. Wright centered around the topic of the price of uranium, its past and future fluctuations, and the consequent effect on continued prospecting for the metal is summarized. It was predicted that breeder reactors will be built before uranium extraction from the sea becomes necessary. Future trading in forms of uranium other than yellow cake was discussed, with special reference to the plans of the Rio Tinto-Zinc Corp. for fuel cycle conversion. (K.S.W.)

20308 CORRELATION OF PRECAMBRIAN ORE PROVINCES OF EAST AFRICA, INDIA, AND WEST AUSTRALIA. Banerjee, P. K.; Ghosh, Sibdas. Econ. Geol.; 67: No. 1, 55-62(Jan-Feb 1972).

On the basis of the recent stratigraphic, tectonic and isotope age data, an attempt was made to classify and correlate the Precambrian tracts of Eastern Africa, South and East India and Western Australia. The stratigraphic assemblages of the Archean-Proterozoic sequences reveal a broad parallelism from the Katarchaean granulite tracts at the base up to the Upper Proterozoic Katangan–Kaimur–Cardup sequence. Six metallogenetic epochs are recognizable. The corresponding metallogenetic provinces are: (i) the Granulite province of India, Ceylon, E. Africa and W. Australia, containing deposits of graphite, ilmenite, rutile, zircon and gemstones with local Cu–Pb–Zn–Mo–La concentrations; (ii) the Nyanzian–Kavirondian–Dharwar–Kalgoorlie province containing deposits of Fe, Mn, Ni, Cr, Au etc. with minor Cu, Pb, Zn, Sb, Sn etc.; (iii) the Mayumbian–Bonai–Mt. Bruce province containing Fe, Mn, Au, Cu, Pb ore deposits; (iv) the Ruzizian–Singhbhum–Gangpur province containing Cu, Pb–U, Ni, Mo, Cr, La mineralization; (v) the Kibaride–Karagwe–Ankole–Chotanagpur–Cuddapah–Bangemall province containing Sn and W mineralization, located along the contact of the batholiths as well as Pb–Cu deposits and diamondiferous diatremes; and (vi) the Katanga–Bukoban–Kaimur–Cardup province containing syngenetic Cu–Ni–Co–U mineralization. On the basis of this correlation, potential targets for further exploration are: (i) Cr in Yilgarn block (W. Australia); (ii) Mn, Ni, Cr, Au in Nyanzian (Tanzania and Uganda) and Fe, Mn, Cu, Pb in Mayumbian (S.E. Congo) sequences; (iii) Sn around Closepet Granite (Mysore) and Chotanagpur batholith (Bihar–Orissa); (iv) Ni in the Dharwarian ultramafites; (v) Cu and U in Bukobans (Tanzania), in Kaimurs (India) and in Cardup formation (W. Australia). (auth)

20309 URANIUM–ORGANIC MATTER ASSOCIATION AT LA BAJADA, NEW MEXICO. Haji-Vassiliou, Andreas (Rutgers–The State Univ., Newark, N. J.); Kerr, Paul F. Econ. Geol.; 67: No. 1, 41-54(Jan-Feb 1972).

Urano-organic matter at La Bajada is associated with sulfide mineralization along a fault in an altered tuff-breccia (Oligocene). The deposit is believed to be hydrothermal and probably represents an aftermath of igneous activity. Underlying coal- and oil-bearing units (Mesa Verde) are believed to have provided the organic fractions in the urano-organic matter. Physicochemical evidence indicates that petroleum was the major source. Geological features and mineral associations suggest that petroleum derivatives escaped to the place of deposition soon after the fracturing of the rocks and were then followed by the uranium-bearing hydrothermal solutions. Although specific uranium minerals have not been identified in the ore, preliminary data suggest that most of the uranium is associated with submicroscopic mineral matter disseminated through the organic components. (auth)

20310 URANIUM AND THORIUM IN ALKALINE OLIVINE-BASALT SERIES. Gladkikh, V. S.; Lebedev-Zinov'ev, A. A. (Inst. of Mineralogy, Geochemistry, and Crystal Chemistry of Rare Elements, Moscow). Geokhimiya; No. 11, 1315-23(Nov 1971). (In Russian).

Uranium and thorium distribution has been studied in 158 samples of effusive rocks of alkaline olivine-basalt series (Maimecha–Kotuisk and Kuznetsko–Alatau provinces zone of grabens in the southern part of the Russian platform). It has been established that lavas of different provinces, being of the same type, are characterized by similar concentrations of radioactive elements. Maximum concentrations of uranium and thorium are noted in differentiates of alkaline olivine-basalt magma having the highest content of sodium and potassium. (auth)

20311 URANIUM CONTENT IN BLACK BITUMINIFEROUS ARGILLITES OF THE UPPER JURASSIC OF THE WEST-SIBERIAN PLATFORM. Pluman, I. I. (Geological Board, Novosibirsk, USSR). Geokhimiya; No. 11, 1362-8(Nov 1971). (In Russian).

Information about the regional elevated uranium content of black bituminiferous argillites of the upper Jurassic strata of the West-Siberian platform is given (content: n = 10^{-3}% to 0.007%). Uranium-containing argillites have an organic carbon content of up to 10% and more and elevated contents of molybdenum, vanadium, and zinc. (auth)

Radioactive Effluents

Refer also to abstracts 20186, 20227, 20327, 20960, 20963, 20964, 22215, 22299, 22308, 22309, 22312, 22317–22320, 22328, 22329, and 22331.

20312 (DOCKET-50201-111) WEST VALLEY REPROCESSING PLANT. X/Q Data, 1971. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 8 Mar 1972. 2p. Dep. NTIS.

Average X/Q values integrated for the year and the four seasonal quarters for each $\pi/8$ sector about the stack were evaluated. (M.C.G.)

20313 (DOCKET-408027-7) SEQUOYAH URANIUM HEXAFLUORIDE PRODUCTION PLANT. Discussion and Findings Relating to Suspension of the Operating License Pending NEPA Environmental Review. (Division of Materials Licensing (AEC), Washington, D. C.). 29 Feb 1972. 16p. Dep. NTIS.

It was determined that the license for the Sequoyah UF_6 Production Plant should not be suspended pending completion of the NEPA environmental review. Plant location and land use, plant process, raffinate waste, fluoride waste, gaseous waste, nitrate waste, sewage waste, soil and vegetation sampling, water use and heat dissipation, accidents, foreclosure alternatives, cost of suspending operations, and balancing factors are discussed. (M.C.G.)

20314 (DOCKET-408027-8) SEQUOYAH URANIUM HEXAFLUORIDE PRODUCTION PLANT. Fluoride Content of Vegetation in Vicinity. (Kerr-McGee Corp., Oklahoma City, Okla.). 11 Feb 1972. 2p. Dep. NTIS.

Samples of vegetation were collected and their fluoride contents determined. The fluoride content of the off-gas stack from the HF scrubber was measured as 1.27 pounds per day, which gives a concentration at the stack of 0.75 ppM. (M.C.G.)

20315 (DPST-70-445) SAVANNAH RIVER WATER QUALITY STUDIES, 1965–1969. Marter, W. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug 1970. Contract AT(07-2)-1. 27p. Dep. NTIS.

Environmental radioactivity data obtained by the Savannah River Plant monitoring group for the years 1965 through 1969 are reported. The minute amounts of radioactive materials in river water have exhibited a decreasing trend since 1966, reflecting reduced amounts released by SRP to its effluent streams. This is the result of reduction in the number of operating nuclear reactors at SRP and improved containment of radioactive materials. Average concentrations of radionuclides in river water downstream from the plant in 1969 were: tritium, 7.9 pCi/ml (0.26% MPC); cesium-137, 0.7 pCi/l (0.004% MPC); strontium-90, 1.1 pCi/l (0.28% MPC); and iodine-131, 0.2 pCi/l (0.07% MPC). Fallout tritium and strontium-90, both measurable in upstream water, constituted 11% and 73%, respectively, of these radionuclides measured downstream from SRP. No changes of chemical water quality or organic pollution were observed that could be assignable to the Savannah River Plant operations. (M.C.G.)

20316 (KURRI-TR-92) EXAMINATION OF LOW RADIOACTIVE WASTE WATER QUALITIES. I. Tsutsui, Tenson; Kimura, Syojiro (Kyoto Univ. (Japan). Research Reactor Inst.). [1971]. 13p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The qualities of low radioactive waste water at the Research Reactor Institute, Kyoto Univ. were measured from April 1964 to August 1971. The values of turbidity, residue, K^+, NH_4^+, SO_4^{2-}, Cl^-, and ABS concentration in waste water were several times as high as those in tap water. The peak value of distribution of Na^+ concentration in waste water was about twice as high as those in tap water. But in a few samples of waste water, Na^+ concentration was about 2000 ppM. (auth)

20317 (LF-44) FISSION PRODUCT INHALATION PROGRAM. Annual Report, October 1, 1970–September 30, 1971. McClellan, R. O.; Rupprecht, F. C. (eds.) (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971. Contract AT(29-2)-1013. 373p. Dep. NTIS.

Fifty-one papers related to research conducted from October 1970 to October 1971 at the Lovelace Foundation on the biological effects of radioisotope inhalation are presented. A separate abstract was prepared for each of 42 papers. Nine were not within the scope of NSA. These nine include information on the production of laboratory dogs, methods for handling canine blood and tissue samples, chemical studies of lungs, methods for handling laboratory data, and the effects of bronchopulmonary lavage in dogs. (L.C.L.)

For abstracts of individual papers see: 20221, 20603, 20632–20648, 20651–20665, 20965–20971, and 22454.

20318 (ORP/SID-71-1) RADIOACTIVE WASTE DISCHARGES TO THE ENVIRONMENT FROM NUCLEAR POWER FACILITIES. Logsdon, Joe E.; Robinson, Thomas L. (Office of Radiation Programs, Washington, D. C. Surveillance and Inspection Div.). Oct 1971. 33p. (BRH/DER-70-2(Add.1)). NTIS.

Discharges of liquid and gaseous radioactive wastes from 13 nuclear power facilities through 1970 are summarized. Discharges are also compared to power production. (auth)

20319 STUDY OF THE DISPERSION OF RADIOACTIVE EFFLUENTS INTO A LAKE. I. CONTAMINATION OF THE BOTTOM SEDIMENTS. de Bortoli, M.; Gaglione, P. (Joint Nuclear Research Centre, Ispra, Italy). Minerva Fisiconucl.; 14: No. 4, 190-6(Oct-Dec 1970).

A gamma spectrometry survey was carried out in a bay of Lake Maggiore (Northern Italy) to evaluate the amount and distribution of the contamination in the bottom sediments. This contamination is due to the release of radioactive effluents (almost entirely ^{60}Co and ^{137}Cs) from the Euratom Ispra Establishment via a brook (Novellino), which runs into the bay. The field measurements have been confirmed and completed by gamma spectrometry analyses performed in the laboratory on sediment samples from the brook and the bay. Through these measurements the vertical profile of the contamination has been also determined and found very irregular. The contamination in the bay is confined to an area of approximately 0.03 km^2 and the activity levels found are very low, as expected on the basis of the activity released. The mean ^{60}Co concentration, which has been discharged in amounts about 5 times higher than ^{137}Cs, is 0.5 pCi/g of dry matter in the most highly contaminated layer, i.e., that from 0 to 7.5 cm. The total deposit of ^{60}Co per area unit is about 78 mCi/km^2 and the associated contact dose-rate is approximately 1.4 μrad/h. (auth)

20320 MUST FOSSIL FUELS POLLUTE? Perry, Harry; Berkson, Harold (Library of Congress, Washington, D. C.). Technol. Rev.; 74: No. 2, 34-43(Dec 1971).

Opportunities of channeling environmental pollution associated with fuel consumption into more useful outlets are discussed. It is noted that the greatest potential for developing uses for waste fuel at present is for materials generated in relatively large quantities at single locations whose potential applications are associated with physical or chemical properties. The solution of preference is usually one in which the waste is turned into a useful resource. Discussions are included on mine and preparation plant wastes, fly ash utilization, petroleum production wastes, gaseous wastes, and utilization of waste heat. (J.R.D.)

Radioactivity Transport and Monitoring

Refer also to abstract 20981.

20321 (CONF-700909–, pp 107-14) PREPARATIONS AND USE OF FALLOUT SIMULANTS IN BIOLOGICAL EXPERIMENTS. Lane, William B. (Stanford Research Inst., Menlo Park, Calif.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Facilities developed by the Office of Civil Defense for the production of synthetic fallout are described. The steps in producing synthetic fallout include mineral processing to produce sized particles in ton quantities, radioisotope processing in the hot cells, radiotagging the mineral particles in concrete mixers and high-temperature furnaces, and testing and control to ensure the radiochemical, chemical, and physical properties of the synthetic fallout. The capability for simulating nuclear fallout is reported and is exemplified by a description of the production of a 300 pound batch of synthetic fallout tagged with 15 Ci of ^{137}Cs and a small routine batch of synthetic fallout tagged with ^{90}Y which is produced once or twice a month. (H.L.W.)

20322 (CONF-710617-(Vols.1 and 2), pp 95-113) NUCLEAR RADIATION MOLEHILL. Landis, John W. (Gulf General Atomic Co., San Diego, Calif.).

From twelfth annual meeting of the Nuclear Materials Management; West Palm Beach, Fla. (29 Jun 1971).

The recent contentions by environmentalists that radiation releases from nuclear facilities exceed acceptable safety standards are refuted by data on the dose rate to US citizens from natural background radiation, commercial coal-burning power plants, medical uses of x rays and fluoroscopy, ingestion of radioisotope-containing foods (including beer), etc. These data are compared with dose rates due to actual radiation releases

from nuclear power facilities. However, acceptance of these facts is considered to be of secondary importance to the necessity for reassuring the general public of the benefits of nuclear power and for publishing the results of all radiation release studies and release standards evaluations in the mass media. (L.C.L.)

20323 RESULTS OF A SURVEY OF X RADIATION FROM COLOR TELEVISION RECEIVERS IN THE METROPOLITAN AREA OF SAN JUAN, PUERTO RICO, 1969–1970. Radiol. Health Data Rep.; 12: No. 11, 547-51(Nov 1971).

In 1969 to 1970, the Puerto Rico Department of Health surveyed 1,276 color television sets for emission of radiation. Only 34 (2.7 percent) of these sets were found to be emitting radiation in excess of 0.5 mR/h at 5 cm from the surface of the receiver. (auth)

20324 SPACE PROGRAMMES AND INTERNATIONAL ENVIRONMENT PROTECTION. Sand, P. H. (Food and Agriculture Organization of the United Nations, Rome). Int. Comp. Law Quart.; 21: Pt. 1, 43-60(Jan 1972).

A short section is included on nuclear radiation as an environmental hazard of space programs, with reference to small radioisotope thermoelectric generators and the advent of rocket nuclear propulsion systems. Mention is also made of high-altitude nuclear explosions and the Nuclear Test Ban Treaty. (UK)

20325 RADIOAKTIVITA HORNIN CESKEHO MASIVU. (Radioactivity of Rocks in the Bohemian Massif). Matolin, Milan. Prague; Academia (1970). 100p.

The radioactivity of rocks in the Bohemian Massif is described and explained. Rock characteristics are given of both the Bohemian Massif ground structures (the Moldanubicum, Assynth Block, Caledonian Block, Saxon–Durynian Block) and the top structures, including the Permian–Carboniferous Basin, Mesozoics, Tertiary, and the youngest formations of the Bohemian Massif. The data on the total rock radioactivity of the Bohemian Massif were obtained by regional aerial measurements, local aerial and ground radiometric survey, and by extensive laboratory activity measurements. (auth)

Atmosphere

Refer also to abstract 20312.

20326 (SWRHL–59-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE PIN STRIPE EVENT, APRIL 25, 1966. (Western Environmental Research Lab., Las Vegas, Nev.). Feb 1972. 78p. Dep. NTIS.

The Public Health Service provided off-site surveillance in support of the Pin Stripe Event conducted on April 25, 1966, at the Nevada Test Site. This support consisted of tracking the effluent, monitoring radiation dosage to the off-site population, collecting and analyzing environmental samples of air, milk, water and vegetation, and conducting an intensive public relations program for the off-site residents. The maximum net gamma exposure rate measured by a portable survey instrument was 8 mR/hr. This reading was taken along a gravel road used only occasionally and well away from any continuously occupied area. The highest net gamma exposure rate measured at a continuously occupied location was 1.5 mR/hr. The above exposure rates were taken during cloud passage. The maximum gross beta concentration found on an air filter from a continuously populated area was 25,000 pCi/m^3. This filter showed a ^{131}I concentration of 5300 pCi/m^3. The highest concentration of ^{131}I in a domestic water supply was 3860 pCi/l and the highest concentration of ^{131}I in a single milk sample was 4800 pCi/l. This concentration (4800 pCi/l) appeared three days after the event and was not representative of the levels of ^{131}I actually consumed by any off-site resident. Dilution of milk from this dairy with milk from dairies outside of the contaminated area, lowered the level of ^{131}I to a maximum of 100 pCi/l. Off-site residents in the affected area, who volunteered, were counted for thyroid burdens in a mobile thyroid counting trailer. The highest total integrated dose was less than 300 mrad. All levels of environmental radiation contamination were below presently accepted safety criteria as established by the U. S. Atomic Energy Commission Standards for Radiation Protection, chapter 0524, dated 8/12/63. (auth)

20327 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 12: No. 11, 586-93(Nov 1971).

Data and information are presented on environmental radioactivity at Atomic Energy Commission installations. Sections are included on Bettis Atomic Laboratory and Oak Ridge area. Data on nuclear detonations during October 1971 and on power reactors in the U. S. are also included. (J.R.D.)

20328 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep.; 12: No. 11, 580-5(Nov 1971).

Results of surveillance of radioactivity in air and precipitation are presented. Information is included on radiation alert network, Canadian air and precipitation monitoring, Pan American air sampling program, and Pu in airborne particulates. (J.R.D.)

20329 COMPARISON MEASUREMENTS OF THE CONCENTRATION OF DAUGHTER PRODUCTS OF EMANATIONS IN AIR. Zhdanova, N. F.; Labushkin, V. G. Meas. Tech. (USSR) (Engl. Transl.); 14: No. 8, 1255-7(Aug 1971).

Translated from Izmer. Tekh.; 14: No. 8, 73-5(Aug 1971).

Calibration of ^{226}Ra and ^{228}Th sources using a 4π flow counter is described. An improvement in the amplifier of the apparatus is also described which extends its use to separately counting alpha particles and beta particles when nuclides emitting both are present in a source. This procedure along with the use of semiconductor alpha spectrometers can be used for accurate measurements of the activity of sources which do not emanate inert gases. The use of sources calibrated in this manner for reduction of errors in measuring the concentration of daughter products of emanations in air is discussed. (J.R.D.)

20330 ROLE OF THE INDIAN MONSOONS IN THE INTERHEMISPHERIC TRANSPORT OF RADIOACTIVE DEBRIS FROM NUCLEAR TESTS. Gopalakrishnan, S.; Rangarajan, C. (Bhabha Atomic Research Centre, Bombay). J. Geophys. Res.; 77: No. 6, 1012-16(20 Feb 1972).

Measurements of the concentrations in Indian surface atmosphere of short-lived fission products, ^{140}Ba and ^{95}Zr, from the French tests in Polynesia, which were carried out during 1968, 1970, and 1971. The data show that the debris reached the west coast of India 15 to 22 days after the burst date for the three test series, which strikingly confirms all previous findings based on the 1968 and earlier test debris. A comparative study of the levels of short-lived fission products at various stations in the northern and southern hemispheres following the French tests is also presented. The results of this comparison show that the rapid transport of air masses across the equator by the southerly jet results in levels in India (west coast) that are up to an order of magnitude higher compared to levels at the same latitude in other meridians. The above radioactive data are consistent with recent meteorological studies on the magnitude of interhemispheric exchange in the west Indian Ocean. (auth)

20331 ATMOSPHERIC RADIOACTIVITY ALONG THE HASL GROUND-LEVEL SAMPLING NETWORK, 1968 TO MID-1970, AS AN INDICATOR OF TROPOSPHERIC AND STRATOSPHERIC SOURCES. Telegadas, Kosta (National Oceanic and Atmospheric Administration, Silver Spring, Md.). J. Geophys. Res.; 77: No. 6, 1004-11(20 Feb 1972).

Radioactivity concentrations and activity ratios in air sampled at ground-level locations are useful in correlating the latitudinal spread of nuclear debris with a tropospheric or stratospheric source. In late 1968 and again in late 1969, China detonated a high-yield nuclear device in the northern hemisphere (40°N), and France conducted a nuclear test series (22°S) in mid-1968 and in mid-1970. An examination of the ^{95}Zr concentrations and ^{95}Zr to ^{144}Ce activity ratios indicates several time and space regions with similar radioactivity characteristics that can be related to one of these specific sources of debris. (auth)

20332 ^{212}Pb IN THE URBAN BOUNDARY LAYER OF NEW YORK CITY. Assaf, Gad; Biscaye, Pierre E. (Columbia Univ., Palisades, N. Y.). Science; 175: No. 4024, 890-4(25 Feb 1972).

The radioactive emanation product ^{212}Pb is useful in estimating rates of air exchange within the urban boundary layer. The concentration of ^{212}Pb is negligible in air of oceanic origin as well as in air above continental areas under snow cover. On several days when conditions were such that one of these types of air mass approached New York City, measurements were made which show that the source strength of ^{212}Pb within the city is relatively constant. On two such days vertical profiles of the concentration of ^{212}Pb were measured from the Empire State Building, which served as a sampling tower. From the data of these profiles and a two-layer model of the urban boundary layer, we estimate the vertical eddy diffusivity to be of the order of tens of m^2/s and the residence time of air within the street layer to be of the order of 5 min. These results are consistent with the observed distribution of stable lead and with an independent estimate of the eddy viscosity from a wind profile. Under moderate wind conditions and with a mixing depth of hundreds of meters, virtually all the horizontal transport of ^{212}Pb and other tracers with street-level sources takes place in the advective layer. (auth)

20333 RADIOKRYPTON IN THE ATMOSPHERE. Suzuki, Tatsusaburo; Inoue, Kazumasa (Meisei Univ., Tokyo). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 55-7(Jan 1972).

It is known that radiokrypton (^{85}Kr) in the atmosphere is mainly produced by the spontaneous fission of natural U, neutron-induced fission in reactors, and in nuclear explosions. Data are included as a basis for estimates that the activity of ^{85}Kr originated by spontaneous fission is less than 0.1 $\mu\mu$Ci/mol of Kr in the atmosphere. Thus it may be concluded that most of the ^{85}Kr now present in the atmosphere was produced by reactors or by nuclear explosions. (J.R.D.)

Soil

Refer also to abstract 20578.

20334 (USGS-474-115) RADIOCHEMICAL ANALYSIS OF WATER SAMPLES COLLECTED AFTER THE SALMON EVENT IN THE VICINITY OF TATUM SALT DOME, LAMAR COUNTY, MISSISSIPPI. Janzer, V. J.; Robinson, B. P.; Rucker, S. J. (Geological Survey, Denver, Colo.). 1965. Contract AT(29-2)-474. 33p. Dep. NTIS.

On the basis of the analytical methods used, radiochemical analyses of water samples collected periodically after the Salmon Event show that no detectable level of radioactive contamination exists in the samples analyzed to date. Samples were obtained from the calcite caprock at a depth of 934 to 1,006 feet and through intervening aquifers to aquifer 2a at a depth of 590 to 680 feet from the surface. Tritium and gross beta determinations were made on all samples. Periodic sampling of the wells probably will be continued for some time but the number of analyses will be reduced. (auth)

20335 BACKGROUND RADIOACTIVITY OF THE GROUND WATERS OF THE UKRAINE. Tutarova, A. B. Geol. Zh. (Russ. Ed.); 31: No. 1, 91-7(1971). (In Russian).

A brief description is given of the radioactivity of ground waters (uranium and radon) in the Ukrainian shield, northwestern Donets Basin, and Carpathian region of the Ukraine. The procedure of calculating background concentrations and the main factors affecting their formation and distribution laws are examined. The data and conclusions are of practical and theoretical value in planning hydrochemical work. (Geophys. Abstr.)

Water

Refer also to abstract 20011.

20336 (BNWL-1638) SEASONAL CHANGES IN PARTICLE SIZE DISTRIBUTION, COMPOSITION, AND STRONTIUM EXCHANGE CAPACITY OF PARTICULATE MATTER SUSPENDED IN THE COLUMBIA RIVER. Wildung, R. E.; Routson, R. C.; Schmidt, R. L. (Battelle Pacific Northwest Labs., Richland, Wash.). Jan 1972. Contract AT(45-1)-1830. 32p. Dep. NTIS.

A centrifugation method was employed to fractionate, according to equivalent spherical diameter, particulate matter suspended in the Columbia River during November, February, April, June and August. The isolated size fractions were characterized as to particle size distribution, carbon content, predominant primary and secondary minerals and strontium exchange capacity. The results were related to watershed characteristics and seasonal changes in river conditions. Relative to other seasons, the concentration of suspended matter increased markedly (over 100 fold) during the spring freshet. This increase was accompanied by a change in particle size distribution with the clay size fraction (<2.0 μ) accounting for approximately 63% of total solids compared to a range from 14 to 30% for other periods of the year. Of the total suspended sediment load in the spring 24% and 8% occurred in the <0.5 and <0.2 μ fractions, respectively. Primary minerals inherited from parent rocks (quartz, feldspar and amphibole) and the layer silicate mineral species (mica-illite, chlorite and montmorillonite) were generally present in particulate matter isolated throughout the year. Whereas seasonal changes in the primary mineral composition were not pronounced, the relative concentrations of the layer silicate minerals commonly present in soils increased during spring and summer corresponding to the periods of spring runoff and the return of irrigation water to the river. Mineral composition also differed between size fractions. Montmorillonite, a layer silicate mineral of comparatively high ion exchange capacity increased in relative abundance with decreased particle size. The Sr exchange capacity of materials isolated in the spring increased with decreased particle size ranging from 11.5 to 93.9 me./100g for the >2.0 μ and <0.2 μ fractions, respectively, likely reflecting relative differences in mineral type as well as increased reactive surface area. Increases in suspended particulate concentration due to spring runoff and the return of irrigation waters results in a large capacity for cation sorption and transport during the spring and summer months. In fact, the Sr exchange capacity of particulate matter in equivalent volumes of river water amounted to from 6 to 26 times higher in the spring than during other periods of the year. (auth)

20337 (CSIRO-Trans-10757) TRITIUM IN INVESTIGATION OF SURFACE HYDROLOGY. EXPERIMENTAL DETERMINATION OF COEFFICIENT OF RUNOFF. Crouzet, Edith; Hubert, Pierre; Olive, Philippe; Siwertz, Erik; Marce, Adrien. Translated by D. R. Eddy (Commonwealth Scientific and Industrial Research Organization, Australia), from J. Hydrol.; 11: 217-29(1970). 5p. Dep. NTIS (U. S. Sales Only).

A tracer technique is described which uses measurements of the ^{3}H content in rainwater and river water to determine the participation of rainfall in river flow during a flood. Experimental results with this method indicate that if the duration of the flood is less than the transit time of ground waters in the region studied, it is not necessary to measure the tritium content of the subterranean waters. However, if the duration of the flood exceeds the ground water transit time, the tritium contribution by ground water in the region must be considered. (L.C.L.)

20338 DATA, SECTION II, WATER. Radiol. Health Data Rep.; 12: No. 11, 571-9(Nov 1971).

Water sampling and analysis in the U. S. are reported. Data and information are included on gross radioactivity in surface waters of the U. S. during March 1971, radioactivity in Minnesota municipal water supplies during January through June 1970, and tritium surveillance in the U. S. during April through June 1971. (J.R.D.)

20339 DISTRIBUTION OF ^{137}Co IN THE LIGURIAN SEA. Le Beyec, Y. (Paris Univ., Orsay France); Morel, A.; Slizewicz, P. Cah. Oceanogr.; 23: No. 9, 859-69(Nov 1971). (In French).

Preliminary results of measurements made on the ^{137}Cs (a radioactive product from nuclear explosions) concentrations at different places and depths in the Ligurian Sea, are presented. The values obtained at the surface showed that diffusion had taken place. The intermediate depth water was contaminated. At greater depths (1000 to 1500 m) the ^{137}Cs concentration was less than 10% of its value at the surface indicating that the fraction of diffused surface water is small compared with the bulk of deep water. The depth integrated values obtained for fallout at particular places were smaller than the total fallout expected at these places. (France)

20340 HORIZONTAL AND VERTICAL DISTRIBUTIONS OF RADIONUCLIDES IN THE NORTH PACIFIC OCEAN. Silker, W. B. (Battelle-Northwest, Richland, Wash.). J. Geophys. Res.; 77: No. 6, 1061-70(20 Feb 1972).

Concentrations of ^{7}Be, $^{95}ZrNb$, ^{106}Ru, and ^{144}Ce were determined in surface water and vertical profiles in the North Pacific Ocean. Latitudinal distribution of radionuclides in equatorial waters differed from previous patterns of both terrestrial and oceanic fallout of long-lived fission products. Fallout rates were quite uniform across narrow latitude belts, with constant amounts of radionuclides occurring both vertically and horizontally in the water mass. The short-lived radionuclides were uniformly distributed in the mixed layer, but decreased in concentration as the thermocline was penetrated. Vertical eddy diffusion coefficients, calculated from ^{7}Be and $^{95}ZrNb$ data, were 0.5 to 0.7 cm^2/sec within the upper boundary of the main oceanic thermocline. (auth)

20341 URANIUM IN RUNOFF FROM THE GULF OF MEXICO DISTIRBUTIVE PROVINCE: ANOMALOUS CONCENTRATIONS. Spalding, Roy F.; Sackett, William M. (Texas A and M Univ., College Station). Science; 175: No. 4022, 629-31(11 Feb 1972).

Uranium concentrations in North American rivers are higher than those reported 20 years ago. The increase is attributed to applications to agricultural land of larger amounts of phosphate fertilizer containing appreciable concentrations of uranium. Experiments showing a constant phosphorous-uranium ratio for various types of fertilizers and for the easily solubilized fraction of 0-46-0 fertilizers support this view. (auth)

20342 BALANCES OF ^{90}Sr AND ^{137}Cs IN THE BALTIC SEA. Voipio, Aarno; Salo, Anneli (Inst. of Marine Research, Helsinki. Inst. of Radiation Physics, Helsinki). Nord. Hydrol.; 2, 57-63(1971).

The total amounts of ^{90}Sr and ^{137}Cs that accumulated in the water of the Baltic Sea in the years 1960 to 67 were estimated on the basis of 10 to 15 samples collected annually in different parts of the Baltic Sea. The changes found in the amounts were compared with evaluated effects of decreasing and increasing processes. (auth)

Ecosystems and Food Cycles

Refer also to abstract 20262.

20343 (BMI-171-134) AMCHITKA BIOENVIRONMENTAL PROGRAM. STUDIES OF THE AVIFAUNA ON AMCHITKA ISLAND, ALASKA. Annual Progress Report, July 1, 1970–June 30, 1971. Williamson, Francis S. L.; Emison, William B.; White, Clayton M. ([Smithsonian Institution, Edgewater, Md. Chesapeake Bay Center for Environmental Studies]). Feb 1972. Contract AT(26-1)-171. 38p. Dep. NTIS.

For Battelle Columbus Labs., Ohio.

The two new species, added to the list of birds occurring on Amchitka, make 91 encountered during this study. Of the 103 recorded over the past 20 years, 52 are considered to be of regular occurrence, and 51 are of accidental or casual occurrence. Two more ecologic formations (offshore islets and disturbed areas), considered important to nesting and feeding birds, are described, and the birds utilizing them are discussed. The summer and winter populations of birds occurring on or near Amchitka are estimated to be composed of about 50,000 and 30,000, respectively. Twenty-seven species of birds are known to nest on Amchitka, and three others probably do so. The primary food types eaten by the 52 regularly occurring birds are plants, insects, crustaceans, mollusks, echinoderms, birds, and fishes. Food items in each of these categories and the birds feeding upon them are discussed in detail. Long-term studies on the effects of Milrow show no direct test-related reduction of avian populations, although there are indications that habitat disturbances from related construction activities may be causing slight population declines in localized areas. The major areas of concern about the effects of Cannikin on the avifauna are possible habitat and nest-site destruction, and possible uptake of accidentally released radionuclides. Each of these is discussed. (auth)

20344 (CONF-700909) SURVIVAL OF FOOD CROPS AND LIVESTOCK IN THE EVENT OF NUCLEAR WAR. Proceedings of a Symposium held at Brookhaven National Lab., Upton, N. Y., September 15–18, 1970. AEC Symposium Series 24. Bensen, David W.; Sparrow, Arnold H. (eds.) (Brookhaven National Lab., Upton, N. Y.). Dec 1971. 745p. Dep. NTIS.

Forty-two papers on the effects of a nuclear war on agricultural operations were presented at the conference. A separate abstract was prepared for each of 37 papers. Five papers have appeared previously in NSA. For abstracts of these see CONF-700909 in the Report Number Index. (L.C.L.)

For abstracts of individual papers see: 20321, 20345–20347, 20412, 20566–20577, 20591, 20598–20602, 20617–20620, 20624, 20628–20631, 20649, 20650, and 20668–20670.

20345 (CONF-700909–, pp 9-30) PHYSICAL, CHEMICAL, AND RADIOLOGICAL PROPERTIES OF FALLOUT. Norman, J. H.; Winchell, P. (Gulf General Atomic Co., San Diego, Calif.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

The importance to a biological-damage model of physical chemistry associated with the sorption of fission products by fallout is suggested. Calculated sorption behavior for Small Boy fallout of several nuclide chains is demonstrated according to a condensed-state diffusion-limited sorption model. An experiment on glassy Johnie Boy fallout revealed a diffusion-controlled profile of ^{137}Cs in partial support of the calculated model. To describe the biological activity of the various fission-product nuclides the leaching properties of radionuclides in the fallout particles must be understood. As an initial report in this field, the sorbed iodine transport in contact with moist air and solutions was considered. Sodium and iodine leaching from several glasses was also studied. Leaching of fission products from a $CaO-Al_2O_3-SiO_2$ glass a few days after recoil loading was studied. In these leaching studies the data were fitted to several models: surface-reaction-rate-limited, diffusion-limited, and desorption-limited processes. The observation of the pertinence of several models suggests considerable complexity in a leaching model for fallout. (auth)

20346 (CONF-700909–, pp 56-70) MEASUREMENT OF BETA DOSE TO VEGETATION FROM CLOSE-IN FALLOUT. Kantz, A. D. (EG and G, Inc., Goleta, Calif.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Dosimetry experiments are described in which both β and γ-ray doses to the environment and to vegetation were measured with thermoluminescent dosimetric technique in the close-in fallout fields from the Plowshare cratering events Cabriolet and Schooner. The β doses measured were found to be an order of magnitude greater than the γ-ray doses at the same locations. (auth)

20347 (CONF-700909–, pp 81-106) PROPERTIES OF FALLOUT IMPORTANT TO AGRICULTURE. Miller, Carl F. (Systems Operations Corp., Hallock, Minn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

The intrinsic properties of fallout associated with radiological hazards which could affect agricultural operations in the postattack period of a nuclear war include: the radionuclide composition of the fallout material, which determines the energy composition of the γ and β radiation emitted; the physical and chemical properties of the fallout particles (such as size, shape, composition, structure, and solubility) which influence their retention by surfaces; and the solubility and biological availability of specific radionuclides. In terms of crop or agricultural-product output, both operational factors (effects on man and his social system) and biological factors (response of plants and animals) would be important. Since the degree of the hazard to the food-producing agricultural systems would generally depend more on external parameters (such as the available weapon system, form or mode of attack, level of attack, explosive yield of weapons, relative heights of burst, and local and regional weather patterns) than on the properties of the fallout, these parameters are discussed in detail. A major recent development in weapon systems which could have a significant impact on the type and extent of hazard to agriculture in a nuclear war is the Multiple Independent Targeted Reentry Vehicle (MIRV). Estimates of MIRV system capabilities, especially in terms of using many smaller-yield warheads on many smaller targets, are used to identify several important implications for future civil-defense planning and the role of civil-defense capabilities in the relative deterrence posture. If sufficient fallout shelters with protection factors of 130 or more were available for the U. S. population, it appears that the USSR could not deploy sufficient SS-9 missiles to assure the destruction of the U. S. population within the next 800 years (even with MIRV) using currently available technology. Also, the effect of MIRV and the associated lower-yield warheads would be to almost eliminate the widespread fallout effects previously estimated for attacks in which land-surface detonations of weapons in the megaton-yield range have been postulated; a comparable degree of effect on agriculture might be achieved from attacks that are designed to kill more than 65% of the U. S. population if all detonations in rural areas were surface bursts. (auth)

20348 (ORNL-4748) THEORETICAL EVALUATION OF CONSUMER PRODUCTS FROM PROJECT GASBUGGY, FINAL REPORT. PHASE II: HYPOTHETICAL POPULATION EXPOSURES OUTSIDE SAN JUAN BASIN. Jacobs, D. G.; Barton, C. J.; Kelly, M. J.; Bowman, C. R.; Hanna, S. R.; Gifford, F. A. Jr.; Culkowski, W. M. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 29p. Dep. NTIS.

Estimates of doses that might be received by individuals living within the San Juan basin in western New Mexico from the hypothetical use of Gasbuggy gas were given in a previous report (ORNL-4646). Results of those studies are extended to include potential doses to individuals in west coast metropolitan areas. Tritium is the radionuclide of most concern. Calculations show that a maximum annual radiation dose of 2.2 to 2.5 millirems/year might be attained in these areas if gas containing 1 pCi/cm^3 of tritium were used in homes having unvented space heaters. The potential average annual dose to members of the public in the same areas is estimated to be about 0.5 millirem/year. These doses, as well as potential doses resulting from use of liquid hydrocarbons separated from gas and from possible use of by-products manufactured with tritium-contaminated gas fractions, were small compared with the Federal Radiation Council's Radiation Protection Guide of 170 millirems/year (whole body) and with background radiation levels in the normal human environment. (auth)

20349 (SWRHL-56-r) PROTECTIVE ACTION TAKEN AT SCHOFIELD'S DAIRY HIKO, NEVADA FOLLOWING AN ACCIDENTAL RELEASE OF RADIOACTIVITY FROM THE NEVADA TEST SITE. Coogan, John S.; Bliss, Wayne A. (Western Environmental Research Lab., Las Vegas, Nev.). Jan 1972. 9p. Dep. NTIS.

A protective measure applied to decrease radioiodines in a dairy's milk production and the factors judged in choosing the mode of action are defined. On April 25, 1966, an underground nuclear test conducted at the Nevada Test Site released radioactivity to the atmosphere. The highest exposure rate in a populated area was 1.5 mR/hr at Hiko, Nevada, 63 miles from surface ground zero in Pahranagat Valley. Milk samples from Schofield's Dairy at Hiko showed the highest concentrations of ^{131}I. Four cows were fed a regular diet of green chop and grain as a control to assess the effect of protective action. The ^{131}I levels in their milk decreased only about 10% per day. Protective action consisted of feeding the remaining cows dry hay and grain. It was estimated that this action reduced the ^{131}I thyroid dose by 71%. (M.C.G.)

20350 (SWRHL-112-r) RADIONUCLIDE STUDIES IN DAIRY COWS FOLLOWING PROJECT SCHOONER. Black, Stuart C.; McNelis, David N.; Bretthauer, Erich W. (Western Environmental Research Lab., Las Vegas, Nev.). Jan 1972. 30p. Dep. NTIS.

Hay bales were placed 30 to 50 miles from surface ground zero in the predicted downwind direction of the effluent from Project Schooner, conducted December 8, 1968. Subsequent to contamination, the hay was recovered and fed to groups of dairy cows in a controlled ingestion experiment. As noted in similar experiments during the Cabriolet and Buggy cratering tests, the secretion of ^{131}I in milk was below expectations. Less than 4% of the ingested ^{131}I was secreted in milk, and the peak milk concentration was less than half the expected value. Concurrent measurements of ^{187}W transfer indicated that less than 0.07% of the ingested tungsten was secreted in milk and that the peak concentration in milk was only 0.0002 times the peak concentration of tungsten in hay. (auth)

20351 FALLOUT RADIOACTIVITY OF BIOSPHERE ON THE TERRITORY OF THE GDR DURING 1969. Moldenhawer, F.; Schulze-Wollgast, U. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie; 14: No. 7-8, 261-8(Jul-Aug 1971). (In German).

The results of fallout monitoring during 1969 have evidenced further recession of ^{90}Sr and ^{137}Cs contamination in almost all media under investigation. Most obvious was the recession of ^{90}Sr content in the fallout, some plants, and in milk. ^{137}Cs concentration also decreased in fallout and some plants, whereas no change was observed in milk, total diet, grass, and rye grain as compared with the values for 1968. (auth)

20352 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 12: No. 11, 553-70(Nov 1971).

Data summaries for August 1970 through July 1971 on radioisotope content of milk at western hemisphere sampling stations are presented. Information is included on ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, ^{140}Ba, and ^{40}K. Data and information on radioisotopes in institutional diet samples during April through June 1971 in the U. S. are also presented along with data on radioisotope daily intake at stations in California during July through December 1970. Data are also included on ^{90}Sr in diets in New York City, Chicago, and San Francisco during January through December 1970. (J.R.D.)

20353 TRANSFER OF RADIOACTIVE MATERIALS FROM THE TERRESTRIAL ENVIRONMENT TO ANIMALS AND MAN. Garner, R. J. (Colorado State Univ., Fort Collins). CRC Crit. Rev. Environ. Contr.; 2: No. 3, 337-85(Sep 1971).

For almost all situations that can be envisaged involving contamination of the environment with radioactive materials it is clear that the major route of entry of these materials into animals or man would be through contaminated food. Inhalation is likely to be of significance only under exceptional circumstances when considering anything other than occupational exposure. Drinking water is of interest as a source of naturally-occurring radionuclides, but again, in other than exceptional circumstances, is likely to make only a small contribution to the total intake. It needs to be emphasized, however, that these exceptions cannot be ignored and have to be borne in mind when evaluating a specific contamination situation. Nevertheless, it is true to say that primarily the intake of radionuclides is controlled by the level of contamination in foodstuffs and by dietary habits. An attempt has been made to indicate the effect of dietary habits on the total intake of radionuclides and the consequent radiation exposure. This applies to animals as well as to man. No attempt has been made to assess the relative hazards resulting from the intake of individual nuclides. This would require discussion of their behavior within the animal body, a subject which does not come within the purview of the review. Despite efforts to the contrary, much of the review deals with ^{131}I, ^{90}Sr and ^{137}Cs. This has been found to be inescapable because the mass of data available in the literature relates to these nuclides. This is not to say that other radioactive species may not be important in a localized situation and, for this reason, further research is needed on, for example, isotopes of antimony and tungsten, which, from the meager information currently available, appear to be readily transferred from the environment through food-chains. Simple, pedestrian laboratory experiments should suffice since, as has been shown, factors which control the overall behavior of environmental contaminants are now reasonably well understood. (J.R.D.)

20354 RETENTION OF 44 TO 88 μ SIMULATED FALLOUT PARTICLES BY GRASSES. Peters, L. N.; Witherspoon, J. P. (Oak Ridge National Lab., Tenn.). Health Phys.; 22: No. 3, 261-6(Mar 1972).

A quartz fallout simulant containing ^{134}Cs was deposited (1.85 g particles/ft^2) on 4 common species of grasses used for pasture or turf purposes (zoysia, bluegrass, fescue, and bermuda). Initial interception of the fallout simulant varied between species from 68 to 82%. Weathering half-lives of particles on foliage averaged 3.5 ± 0.6 S.E., 36.7 ± 8.6 S.E. and 80.5 ± 39.5 days, respectively, for time periods of 0 to 2.5, 2.5 to 35, and 35 to 48 days following deposition. Particles lost from foliage were mostly trapped by dense mats of stem and dead foliage, and transfer of particles to the soil surface amounted only to 31% of the original deposition at 48 days. It is suggested that fallout contaminated grasses might be expected to receive greater radiation doses and retain more radioactivity for food chain transfers than other agricultural plants with less effective structures for particle retention. (auth)

20355 ^{55}Fe IN RONGELAP PEOPLE, FISH, AND SOILS. Beasley, T. M. (Univ. of Washington, Seattle); Held, E. E.; Conard, R. M. Health Phys.; 22: No. 3, 245-50(Mar 1972).

The ^{55}Fe body burdens for 60 residents of Rongelap Atoll are reported. The measured burdens were approximately 3 times higher than those of a similar number of residents from Tokaimura, Japan. The frequency distributions of ^{55}Fe burdens are listed according to sex and age, and ^{55}Fe content in the liver of the goatfish (Mulloidichthys sp) and in soil samples are also tabulated. (auth)

20356 RADIOACTIVE CONTAMINATION OF THE VENICE LAGOON FROM 1964 TO 1969. Calapaj, G. G.; Ongarno, D. (Univ., Padua). Minerva Fisiconucl.; 14: No. 4, 202-12(Oct-Dec 1970). (In Italian).

A survey of the radioactive contamination from ^{90}Sr, ^{137}Cs and ^{54}Mn of 12 edible species of molluscs and crustaceans of the Venice Lagoon, was carried out from 1964 to 1969. An estimate of the concentration of these radioisotopes in the surrounding water was also attempted, based on their levels in those molluscs whose concentration factor (c.f.) was known from the literature. For the c.f. of ^{90}Sr and ^{137}Cs the lowest values, 0.6 and 6.0 respectively, found in the literature for genera normally living in the Lagoon have been assumed. The c.f. for ^{54}Mn had to be estimated from aquarium experience. The mollusc Pinna nobilis still living in the Venice Lagoon, whose characteristic of accumulating the ^{54}Mn from the environment was already known through previous work was chosen as the critical animal. The average value of this c.f. was 37. Results of the survey showed that in the autumn 1964 the radiocontamination of the molluscs and therefore of the surrounding water from ^{90}Sr was far from negligible, but within a period of three to four months, it fell to a very low level and remained there until the end of the measurements. On the contrary, the contamination of water from ^{137}Cs was almost always absent. The concentration of the ^{54}Mn in water as deduced from that in Pinna, was, during the summer of 1966, some ten times greater than that of the ^{90}Sr, but its decrease was much slower, so that only in the last months of 1969 the level of ^{54}Mn in water became negligible. In the course of the present research, it was determined that, in Carcinus moenas, the ^{90}Sr accumulates only in the shell, so that the c.f. of this crustacean depends strictly upon the proximity of the moulting time. (auth)

20357 UPTAKE AND LOSS OF RADIOACTIVE RUTHENIUM BY FRESHWATER ORGANISMS. Honda, Yoshihide (Kinki Univ., Osaka); Koga, Taeko; Morishima, Hiroshige; Sato, Yasuo; Kitawaki, Shigetomi. Radioisotopes (Tokyo); 20: No. 8, 376-82(Aug 1971). (In Japanese).

The uptake of radioactive Ru by freshwater organisms in a biocenose was studied in an aquarium ecosystem which consisted of natural river water, duckweeds, mud snails, river snails, freshwater mussels, crucian carps, and bottom sands. The aquarium was equipped with a filtration-aeration apparatus. After a single addition of ^{106}Ru in nitrosyl ruthenium nitrato complex forms into the aquarium ecosystem, the uptake and distribution of ^{106}Ru in organisms were observed. The loss of ^{106}Ru from organisms was also studied. The radioactive concentration in rearing water rapidly decreased in 1 or 2 days and then maintained a constant level. The radioactive concentrations of ^{106}Ru in organisms reached peaks in 1 or 2 days, then gradually decreased with a tendency to reach an equilibrium state. The deposition of ^{106}Ru in upper layer of bottom sands reached an equilibrium state in about 7 days. The average concentration factors for ^{106}Ru in organisms showed a decreasing tendency in following order: duckweeds, mud snails, river snails, freshwater mussels and crucian carps. In soft tissues of mud snails, freshwater mussels and river snails, the concentration factors for ^{106}Ru (RuNO-nitrato) were less than about several times in rearing single species. However, in crucian carps no significant difference of the concentration factor for ^{106}Ru was observed with different rearing conditions. In crucian carps, about 80% of total radioactivity was distributed in visceral mass including digestive tract.

The loss of ^{106}Ru in chlorocomplex forms from some organisms was more rapid than that of Ru in nitrosyl nitrato complex forms. Two biological half-lives of ^{106}Ru were observed in some tissues. (auth) (Japan)

20358 DETERMINATION OF ^{90}Sr AND ^{137}Cs IN SOME ELEMENTS IN THE PARAGUAYAN DIET. Caggiano, Maria T.; Facetti, J. F. (Univ., Asuncion, Paraguay). Rev. Soc. Cient. Paraguay; 12: No. 1-2, 5-10(1971). (In Spanish).

Preliminary data are presented on the ^{90}Sr and ^{137}Cs contents of selected components of the human diet in Paraguay. The components included in the study were milk and various parts of manioc plants (cassava). (E.R.B.)

20359 CONCENTRATIONS OF ^{55}Fe IN COMMERCIAL FISH SPECIES FROM THE NORTH ATLANTIC. Preston, A. (Ministry of Agriculture, Fisheries, and Food, Lowestoft, Eng.). Mar. Biol.; 6: No. 4, 345-9(Mar 1970).

Concentrations of the weapon-test fallout ^{55}Fe have been reported for migratory species, such as the Pacific salmon, which suggest a marked decrease in concentration with decrease in latitude of the point of capture. This situation has been examined for North Atlantic cod stocks in order to provide data for a species representative of a large geographical area, but divided into more or less distinct stocks each with a restricted territory, in order to provide further data on the importance of latitude in determining ^{55}Fe concentrations. The data obtained show that there is a marked dependence upon latitude. Arctic cod averaging 90 pCi ^{55}Fe/mg Fe compared with 15 pCi ^{55}Fe/mg Fe for cod from middle latitudes. The mechanisms that could lead to such distribution are examined, and it is concluded that deposition of this radionuclide was exceptionally high over the sea in northern latitudes compared with its deposition on land, and that this pattern of deposition, taken together with the very high biological availability of the material at the time of deposition, has led to the very high specific activities found in northern latitudes and recorded for Arctic cod stocks in particular. (EURATOM)

Radiometric Techniques

Refer also to abstracts 19932, 20514, 20967, and 20968.

20360 (COO-689-136) CORRELATION AND CHRONOLOGY OF ORE DEPOSITS AND VOLCANIC ROCKS. Final Report, 1959-1971. Damon, Paul E. (Arizona Univ., Tucson). Contract AT(11-1)-689. 11p. Dep. NTIS.

Brief summaries are presented for each of approximately 20 separate studies related to research on the age and origin of ore deposits and volcanic rocks in western North America. Information is included on: methodology and development of new dating techniques; isotopic dating of ore deposits and associated igneous rocks; strontium isotope studies; volcanic chronology and regional studies; geological time scale; chemical petrography and trace element studies; and volcanic studies. Information from the above studies was used to develop a theory for relating the geologic history of western North America to current concepts of global tectonics involving sea-floor spreading, plate tectonics, and continental drift. (L.C.L.)

20361 (NP-19203) MEASUREMENT OF SHIFTING SAND ON COASTS WITH HEAVY SURF. Exhibit L 2 at the 4th International Conference on the Peaceful Uses of Atomic Energy, Geneva, 6-16 September 1971. Dolezal, R.; Petersen, M.; Reinhard, R. (Landesamt fuer Wasserwirtschaft Schleswig-Holstein, Kiel (Germany)). [nd]. 25p. Dep. NTIS (U. S. Sales Only).

Details of the equipment and methods used to measure the direction and magnitude of sand shifting off the coast of Sylt Island are presented. Erosion by heavy surf is causing the beaches and cliffs of Sylt Island, located off the west coast of Schleswig-Holstein, to recede at an average rate of 1 m/y. In order to counteract the erosion process, the basic principles of sand movement must be known. ^{46}Sc was used for activating sand. Helicopters were used to deposit the radioactive sand on the off-shore sea floor surface and to carry gamma detection equipment which measured the depth and direction of movement of shifting sand which was deposited over the radioactive sand. Plots of the measured data are presented, but not evaluated nor interpreted. (L.C.L.)

20362 SLOPES OF CURVES OF THE TIME DISTRIBUTION OF THERMAL NEUTRONS AND RADIATION-TRAP GAMMA QUANTA IN A HOMOGENEOUS MEDIUM. Denisik, S. A.; Gommershtadt, V. Ya.; Lukhminskii, B. E.; Rezanov, R. A. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 7, 33-40(1969). (In Russian).

Results are discussed of a Monte Carlo calculation of the space-time distribution of thermal neutrons and radiation-trap gamma-quanta in a homogeneous medium. On the basis of these results, the decrement of decay of particle flux is determined in its application to pulsed neutron-neutron and pulsed neutron-gamma logging. The dependence of the damping decrement on the properties of the medium and sonde dimensions is brought out. (Geophys. Abstr.)

20363 RESULTS OF CALCULATION BY THE MONTE CARLO METHOD OF THE TEMPORAL DISTRIBUTION OF THERMAL NEUTRONS AND RADIATION-CAPTURE GAMMA QUANTA IN TWO- AND THREE-LAYER MEDIA. Gommershtadt, V. Ya.; Denisik, S. A.; Lukhminskii, B. E.; Rezanov, R. A. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 7, 80-7(1969). (In Russian).

On the basis of a Monte Carlo calculation of the distribution of neutrons and gamma quanta in a three-layered medium with cylindrical boundaries, the relative possibilities of pulsed neutron-gamma and pulsed neutron-neutron logging in the presence of a freshwater infiltration zone in the layer are investigated. The depth of penetration of each of these methods is calculated on the basis of particle counting rate and decay decrement. (Geophys. Abstr.)

20364 USE OF SCATTERED GAMMA RADIATION FOR DETAILED INVESTIGATION OF THE CEMENT COLLAR BEHIND OIL WELL CASINGS. Bernshtein, D. A. Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 7, 163-78 (1969). (In Russian).

A new procedure is presented for monitoring the quality of cementation, and a borehole device designed for detailed investigation of the cement collar, the so-called gamma defactometer, is described. In essence, the operation of the device consists of recording the intensity of scattered gamma radiation on the perimeter of the well using a uniformly rotating directional sonde. Curves are produced from whose characteristics it is possible to judge the casing, and the presence of channels and cavities in that collar. Results of model and borehole investigations demonstrate the theoretical advantages of the defectometer over present cement-meters. Results of testing of the device under production conditions are presented, and conclusions are drawn as to its efficiency. Measurement procedures and interpretation are discussed. (Geophys. Abstr.)

20365 RADIOISOTOPES AND GAMMA RADIATION SOURCES FOR X-RAY RADIOMETRIC ORE ASSAYING. Leman, E. P.; Bolotova, N. G. Vop. Razved, Geofiz.; No. 11, 3-11(1969). (In Russian).

Radiometric methods have been employed in ore assaying since 1962; 27 soft gamma emitters, and their radiochemical characteristics, which satisfactorily meet the various requirements of today's applications, are listed. The scintillation energy spectra of 17 isotopes are illustrated graphically and discussed with regard to hard beta components or accompanying bremsstrahlung. Eleven isotopes are tabulated for use as beta emitters or beta-gamma sources. The number of radioisotopes considered satisfactory for geophysical equipment is fairly small: ^{204}Tl, ^{147}Pm, ^{75}Se, ^{170}Tm, ^{85}Kr, tritium-Zr, and tritium-Ti, and even some of these isotopes are very limited in quantity. (K.S.W.)

20366 DETERMINATION OF OIL-FRESH WATER CONTACT BY DETECTION OF DELAYED NEUTRONS. Kostyu, Ya. E.; Osipenko, A. P.; Shkoda-Ul'yanov, V. A. At. Energ. (USSR); 32: No. 2, 466-7(Feb 1972). (In Russian).

The output of delayed neutrons from layers of water and oil by irradiation with α particles was studied over a range of energies of incident α particles. The yield of delayed neutrons from the two media increased somewhat exponentially with increased α energy, and the ratio of neutron outputs from the two media remained practically constant. (K.S.W.)

20367 PORTABLE STANDARDIZATION APPARATUS FOR GAMMA WELL-LOGGING RADIOMETERS. Artsybashev, V. A.; Kozynda, Yu. O. Geofiz. App.; No. 47, 102-5(1971). (In Russian).

A standardization apparatus of rugged construction is described which contains a gamma source, detector, radiometer, scattering plates, and absorber plates. A well-logging diagram of radioactive element content is readily prepared at the borehole. Overall dimensions are 150 × 90 × 200 mm, wt 5 kg. (tr-auth)

20368 TRANSDUCER SYSTEM FOR REMOTE CONTROL EQUIPMENT FOR WELL-LOGGING DURING DRILLING. Sarkisov, I. K.; Talalyan, A. I.; Stepanyan, V. A. Geofiz. App.; No. 47, 122-3(1971). (In Russian).

The ability to operate automatic remote control equipment

during cutting at the borehole increases the amount of useful information recorded. The switching is conveniently accomplished during release of the flushing liquid. The transducer contains a two-bladed rotor, with a lever arm controlling the contact system. Within the body of the transducer is a plastic tube, one end of which is fastened to the shaft, the other end is anchored to the transducer body. The threshold of actuation may be adjusted. (tr-auth)

20369 SMALL PORTABLE WELL-LOGGING STATION. Kirpishchikov, S. P.; Kleshchevnikov, V. N.; Khandorin, A. G. Geofiz. App.; No. 47, 124-5(1971). (In Russian).

Principles of construction and of operation of an electric well-logging station are described. The station consists of a measuring panel, pulse generator, autocompensator-recorder, and power pack. The weight of all units combined is 15 kg. (K.S.W.)

20370 TIME ANALYZER EQUIPMENT FOR PULSED NEUTRON WELL-LOGGING. Urmanov, E. G.; Ippolitov, A. P. Geofiz. App.; No. 47, 138-40(1971). (In Russian).

A time analyzer was assembled from semiconductor triodes, and designed with 12 differential channels for recording the thermal neutron density attenuation curve, and one supplementary channel for background measurement or for ascertaining the induced oxygen activity. (tr-auth)

20371 AMPLIFIER FOR A BOREHOLE PROBE FOR A WELL-LOGGING RADIOMETER. Davydov, A. V.; Polovodov, A. S. Geofiz. App.; No. 47, 158-9(1971). (In Russian).

An amplifier is described which possesses a stable coefficient of amplification, is simple, reliable, and consumes not over 4 mA of current. The thermal stability is at least 5%. The amplifier was assembled from small-scale components and is designed to replace older units with poor efficiency in well-logging probes. (tr-auth)

20372 INPUT AMPLIFIER FOR A WELL-LOGGING RADIOMETER. Baratov, Sh. I.; Davydov, A. V. Geofiz. App.; No. 47, 160(1971). (In Russian).

A schematic diagram is given for a proposed input amplifier for a well-logging radiometer. The amplifier is designed to restore an attenuated signal to its original level of four to five volts, and incorporates a regulated amplification coefficient of from 10 to 100. Its components and operation are discussed. (K.S.W.)

20373 USE OF AN X-RAY RADIOMETRIC ANALYZER TO DETERMINE IRON AND CALCIUM. Vander, I. Z.; Gerling, V. E.; Zgardovskii, V. I.; Nerpin, S. V.; Tsalkin, A. L. Geofiz. App.; No. 42, 138-43(1970). (In Russian).

In determining Fe and Ca in soils, grounds, and rocks, the ^{3}He: Zr, ^{119m}Sn, and ^{55}Fe isotopes are used as radiation sources. To reduce the effect of granulometric composition on the accuracy of the analysis, it is recommended that the samples be screened to 200 mesh or fused with borax. Moisture content up to 6 or 7% and the presence of up to 10% organic matter does not interfere with the determination of iron and calcium. In using the rapid methods of internal standard and standard background, the mean error in analysis of samples with Fe and Ca concentrations up to 20% is from 5 to 8%. (Geophys. Abstr.)

Site Surveys

Refer also to abstracts 20296, 20360, 20958, 20959, 20981, 22322, and 22395.

20374 (DOCKET-408102-2) HIGHLAND URANIUM MILL. Supplement to Applicant's Environmental Report. (Humble Oil and Refining Co., Houston, Tex. Minerals Dept.). Jan 1972. 92p. Dep. NTIS.

Additional information requested by the AEC from the Humble Oil and Refining Company concerning the original Environmental Impact Statement, which accompanied the Highland Uranium Mill source material license application is given. Discussion is included on replies to AEC questions, such as final mine reclamation, environmental effect of sewage treatment plant, chemical composition of gaseous effluents, state permits relating to environment, sampling of food chain, and long-term stability of tailing dam and cost-benefit analysis, including environmental costs, hypothetical environment affecting accidents, and benefits. (P.C.H.)

20375 (DUN-3100) GEOLOGIC FACTORS RELATING TO ENGINEERING SEISMOLOGY IN THE HANFORD AREA, WASHINGTON. Jahns, Richard H. (Douglas United Nuclear, Inc., Richland, Wash.). 1 Oct 1967. Contract AT(45-1)-1857. 37p. Dep. NTIS.

The geological relationships in the Hanford region, particularly those pertinent to tectonic activity in south-central Washington were studied. The tectonic history and activity of this region is an important factor in establishing seismic design criteria for the Hanford nuclear facility. The geologic setting and tectonic features including information on faults, surface breaks, clastic dikes, landslides, and seismicity are discussed. It was concluded that the Pasco Basin region has no great faults, that known breaks are not associated with any master zone of tectonic deformation, and that the region is characterized by low to moderate seismicity during historic time. For seismic design purposes it is recommended that a local earthquake of Magnitude 5.5 is the strongest that could reasonably be expected and that surface ground ruptures from fault displacement in the area can be safely disregarded. (L.C.L.)

20376 (ORO-3822-8) EFFECT OF INPUT DURATION ON FOUNDATION-STRUCTURE INTERACTION. Scavuzzo, R. J.; Little, R. R. (Toledo Univ., Ohio. Dept. of Mechanical Engineering). May 1971. Contract AT(40-1)-3822. 68p. (CONF-710903-8). Dep. NTIS.

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Results of investigations to determine the extent to which large reactor structures interact with free-field seismic ground motion so as to alter the base motion from free-field values are described. The significance of the duration of the seismic ground motion on structure interaction effects and consequent response spectra for a range of relatively idealized simulations of the structure, the foundation conditions, and the input seismic wave form are assessed. Results of the analysis indicate that ground motions from 5 seconds to 10 seconds in length are sufficient to evaluate seismic forces on heavy structural components. Even though the study was not conducted to investigate the response of small equipment structures, preliminary results indicate that longer time durations are needed to obtain the maximum seismic loads than for the heavy structural components. (auth)

20377 (ORO-3822-9) FORMULATION OF THE COUPLED LATERAL-ROTATIONAL INTERACTIONS. Bailey, J. L.; Scavuzzo, R. J.; Raftopoulos, D. D. (Toledo Univ., Ohio). Jun 1971. Contract AT(40-1)-3822. 69p. Dep. NTIS.

Results of research to determine the extent to which the inertia of a large reactor structure will interact with the free-field seismic ground forces to alter the base motion of the structure from that of the free-field and hence to alter the structural forces caused by that base motion are reported. An analysis is made of the combined lateral and rocking motion of the foundation of an N-mass structure coupled to a two-dimensional elastic half-space the free-field motion of which simulates an earthquake. The appropriate Lamb problem is solved in terms of integrals convergent in the Cauchy sense and three pairs of Volterra integral equations are derived—one pair neglecting base-mass effects and the other two pairs including them. The latter two pairs are programmed for numerical solution. The Lamb solution is not sufficiently smooth to permit the required differentiations for obtaining the programmed Volterra equations and some integrals diverge; for this reason useful physical information in addition to that derived from the simpler models neglecting the rocking motion is not found. No attempt is made to program the equations which neglect base-mass effects. The integrals known to diverge do not appear in this formulation. (auth)

20378 (TID-25892) SOIL BEHAVIOR UNDER EARTHQUAKE LOADING CONDITIONS. Interim Report No. 1. (Shannon and Wilson, Inc., Seattle, Wash. Agbabian-Jacobsen Associates, Los Angeles, Calif.). Dec 1971. Contract W-7405-eng-26. 186p. Dep. NTIS.

The results are presented of a year's study in a continuing program for determining the best methods for evaluating and predicting free field soil behavior under earthquake loading conditions. The soil behavior of potential nuclear power plant sites under seismic loading conditions is of particular interest. The subjects covered include: soil modeling studies; in-situ test methods for determining dynamic soil properties; feasibility of using laboratory shake tables for soil liquefaction studies; and supplementary laboratory tests for studying liquefaction. (L.C.L.)

20379 (USGS-474-128) HYDROLOGIC STUDIES, PROJECT DRIBBLE, TATUM SALT DOME, LAMAR COUNTY, MISSISSIPPI. Dribble-9. Lang, Joe W. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 18p. Dep. NTIS.
Report written: 1961.

Hydrologic studies were made to determine the ground water situation over and around Tatum dome prior to nuclear testing. There are at least 4 important fresh-water aquifers, several

local fresh-water aquifers, and at least one underlying saline-water aquifer in the strata surrounding Tatum dome. Caprock test wells were designed to determine the hydrologic properties of the Caprock limestone. Ten wells were planned to test the hydrologic characteristics of aquifers overlying the Caprock limestone on the dome. (M.C.G.)

Thermal Effluents

Refer also to abstracts 20963, 22215, 22299, 22308, 22309, 22317–22319, 22328, 22329, and 22331.

20380 (NP-19176) POTENTIAL ENVIRONMENTAL MODIFICATIONS PRODUCED BY LARGE EVAPORATIVE COOLING TOWERS. (EG and G, Inc., Boulder, Colo.). Jan 1971. 75p. GPO $0.75.

A program directed to development of techniques for evaluating the extent of plumes from large evaporative cooling towers is described. Analytical techniques were used to describe the dynamics of the wet cooling tower plume and its interaction with the environment. Primary emphasis was placed on predicting the height of the plume. Classical atmosphere diffusion theory was used to determine the downwind spread. Results of the study showed that the saturation deficit of the atmosphere clearly controls the downwind spread of the ejected liquid water. Except for cases where the relative humidity approaches 100%, downwind propagation is limited to periods when the air temperature falls below the freezing point. For a given set of atmospheric conditions, increases in the tower radius, the saturation temperature, and the initial vertical velocity of the plume contribute to increasing the final plume height. The potential for adverse atmospheric effects due to cooling towers was analyzed on a national basis and is presented in the form of a map of the United States. A computer program was developed to perform the necessary calculations. A description of the program, including input specifications is included. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 20329, 20367, 20371, 20372, and 20551.

General Detectors and Monitors

Refer also to abstracts 20987–20994, 20996, 20997, 21002, 21005, 21032, 21635, and 21693.

20381 (EURFNR–953) WORK ON SOLID STATE TRACK RECORDERS. Guenther, Gudrum (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Translation of report KFK–1461. 28p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Investigations for the routine application of solid state track recorders for measurements in SNEAK are described. A polycarbonate foil (Lexan) was chosen as a detector material satisfying all requirements. In this type of material fission products leave tracks which can be enlarged by etching until they are visible in a light microscope. A simple model of the etching process was compared to experimental results. In order to increase the contrast of the tracks against the background they were colored using a felt pen. The evaluation is performed with the image analyzer CLASSIMAT, an apparatus designed to count single particles. The operation of the CLASSIMAT was tested and calibration curves were taken. Using some experimental results the principle of operation was demonstrated. A modification of the CLASSIMAT is planned in preparation of a completely automated image analysis using a computer. (auth)

20382 (KFKI–71–64) COMPUTER DATA-PROCESSING FOR A WHOLE-BODY COUNTER. Feher, I.; Andrasi, A. (Maygar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1971]. 14p. (SM–150/16; CONF–711104–3). Dep. NTIS (U. S. Sales Only).

From Symposium on the assessment of radioactive organ and body burdens; Stockholm, Sweden (22 Nov 1971).

The whole-body counter which was installed in 1964 at the Central Research Institute for Physics has been used since then for numerous experiments concerning the determination of occupational, incidental body burdens and for the measurement of the ^{137}Cs burden on the population. Initially a manual procedure was used for the valuation of the gamma spectra from the photopeaks. This method proved to be inaccurate and time consuming and was particularly difficult in most cases where the overall error in a spectrum with several components had to be estimated and a low intensity contribution distinguished from a high intensity line next to it. Therefore, the problem of spectrum stabilization has been solved, and a method was developed for the computer processing of whole-body counter data. The main features of a spectrum stabilizer operating with a reference light source and a system adopted for the transfer, storage and computer-processing of the data are described. The performance of the system is illustrated with reference to some test problems and the sources of error are discussed. Finally the results obtained by computer processing of the measurements of occupational radiation burdens and of the ^{137}Cs burden on the population of Budapest are present. (auth)

20383 (LA–4824, pp 71–5) LARGE CHAMBERS IN EXPERIMENTS AT CERN AND NEVIS. Nygren, D. (Columbia Univ., New York). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The design and performance of large multiwire proportional chambers is discussed. A logic diagram for the chamber electronics and readout is included. (4 figures) (R.W.R.)

20384 (LA–4824, pp 127–8) MULTIWIRE PROPORTIONAL CHAMBERS: AN INTRODUCTION. Steiner, Herbert (California Univ., Berkeley. Lawrence Berkeley Lab.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

A bibliography of 20 references pertaining to multiwire proportional chambers is presented. The author divides them according to the following headings: general, nitty-gritty, electronics and readout systems, variations on a theme, and applications. (R.W.R.)

20385 (LA–4824, pp 129–32) RECENT DEVELOPMENTS IN MULTIWIRE PROPORTIONAL COUNTERS AT RICE. Coulson, L. (Rice Univ., Houston, Tex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

Attempts to improve the spatial resolution of multiwire proportional counters by reducing the wire spacing to 1.2 mm are described. In an effort to reduce the high operating potential required with 1.2 mm spacing in a conventional counter and to improve the field symmetry, intermediate voltage electrodes were placed between signal wires. The fabrication and performance of such a counter for 12-MeV protons are described; the counter was found to operate at an efficiency of 99%. Use of intermediate wires allows the voltage to be reduced by $\frac{1}{3}$ to $\frac{1}{2}$ and a wide operating plateau. A particle normally incident is seen by a particular wire if and only if it passes somewhere between the two intermediate wires adjacent to it; particles passing midway between two signal wires are recorded by one or the other, almost never by both. The counter seems to work equally well for 200-MeV pions. (4 figures) (R.W.R.)

20386 (LA–4824, pp 133–5) HIGH RESOLUTION WIRE SPARK CHAMBERS WITH MAGNETOSTRICTIVE READOUT. Atac, M. (National Accelerator Lab., Batavia, Ill.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

A high-density-gas-filled wire spark chamber with magnetostrictive readout having a resolution of 75 μm is described. Reasons for improved resolution are advanced. Results from the testing of such a counter are discussed. These detectors can provide high resolution in a relatively simple experimental setup. (2 figures, 1 table) (R.W.R.)

20387 (LA–4824, pp 145–9) SOME RESULTS AND REMARKS ON HIGH RESOLUTION MULTIWIRE PROPORTIONAL CHAMBERS. Atac, M. (National Accelerator Lab., Batavia, Ill.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

Some physical and technical problems associated with the multiwire proportional chamber are pointed out; the emphasis is on determining the proper value for the electric field. Developmental work on high-resolution proportional chambers and large-area, large-wire-spacing chambers at NAL is discussed. (6 figures) (R.W.R.)

20388 (LA–4824, pp 151–5) PROBLEM OF SIGNAL DETECTION AND SHAPING FOR PROPORTIONAL WIRE CHAMBERS. Sippach, W. (Columbia Univ., New York). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

Signal detection and shaping were studied in a proportional wire chamber 20×20 cm^2 with 2-mm spaced, 30-μ wire and 8 mm spacing between planes. Chamber signals were studied with respect to shape, time distribution, and operating plateau; comparisons were made between "normal" and "magic" gas. Detection sensitivity requirements were investigated, and three strategies for overcoming problems due to the slow fall of the wire pulse were considered. Delay cable was used to provide the necessary delays, instead of electronic univibrators. (4 figures) (R.W.R.)

20389 (LA–4824, pp 163–70) STATUS OF INTER-LABORATORY DEVELOPMENT OF A WIRE CHAMBER INTEGRATED CIRCUIT. Larsen, R. S. (Stanford Linear Accelerator Center, Calif.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The history and present status of an inter-laboratory program to develop a special TTL integrated circuit for wire chambers are given. Input sensitivity appears to pose the major design problem. Specifications and circuit diagrams are included. (8 figures, 2 tables) (R.W.R.)

20390 (LA–4824, pp 171–3) FAST READOUT SYSTEM FOR MULTIWIRE PROPORTIONAL COUNTERS. Bevington, P. R. (Case-Western Reserve Univ., Cleveland, Ohio). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

A readout system for multiwire proportional counters was developed with attention paid to fast response, high efficiency, and

economy. The logic involved in selection of wires, encoding addresses, and timing is discussed. (5 figures) (R.W.R.)

20391 (LA-4824, pp 181-4) RICE UNIVERSITY MICROPROGRAMMED CAMAC/PDP-11 DATA-ACQUISITION SYSTEM. Buchanan, James A. (Rice Univ., Houston, Tex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The design goal of the Rice University data acquisition system is to output only selected data at the maximum tape transfer rate, with as much real-time analysis as possible. A PDP-11/20 with 24K words of 980-ns interleaved memory serves as the central processor. A microprogrammed I/O processor (MIOP) is the link between the computer and the CAMAC branch highway. The CAMAC MIOP is described in some detail. Command list chaining and data analysis are discussed. Since much of the activity usually required of the central processor is not performed by the MIOP, much more CPU time is available for partial data analysis; less than half the acceptable data rate would saturate a conventional system. (5 figures) (R.W.R.)

20392 GEOMETRY FOR OBTAINING UNPERTURBED ANGULAR CORRELATIONS IN THE PRESENCE OF ELECTRIC FIELD GRADIENTS. Alonso, C. T. (Yale Univ., New Haven); Alonso, J.; Grodzins, L. pp 440-3 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

An experimental geometry is described which makes it possible to measure unperturbed angular correlations in the presence of axially symmetric static electric field gradients. A quantum mechanical description for the effect is presented. Several uses for the effect are discussed. (J.W.R.)

20393 SCINTILLATION EFFECTIVENESS AND IONIZATION POTENTIALS OF SOLVENT AND ACTIVATOR. Biteman, V. B.; Kutsyna, L. M.; Poduzhailo, V. F. High Energy Chem. (USSR) (Engl. Transl.); 5: No. 4, 331-2(Jul-Aug 1971).

Translated from Khim. Vys. Energ.; 5: No. 4, 365-7(Jul-Aug 1971).

An attempt was made to find a semiquantitative dependence of the scintillation effectiveness of certain liquid solutions with activators of a series of oxazoles and oxadiazoles on the ionization potentials of the solvent and activator. The following activators were studied: 2,5-diphenyloxazole (PPO); 2-(1-naphthyl)-5-phenyloxazole (αNPO); 2-(4-biphenylyl)-5-(1-naphthyl)oxazole (BαNO); 2-(4-biphenylyl)-5-phenyloxazole (BPO); 2,5-diphenyloxadiazole (PPD); 2-phenyl-5-(4-biphenylyl)oxadiazole (PBD); 2,5-di-(1-naphthyl)-oxadiazole (αNND). Various solvents were used. All solvents and activators were of scintillation purity. The scintillation effectiveness of the solutions was determined at activator concentrations of 5 g/liter at a medium FÉU-13 photocurrent upon irradiation with a radioactive ^{137}Cs source (0.078 mg-eq of Ra) with respect to a standard which was a solution of para-terphenyl (5 g/liter) + POPOP (0.1 g/liter) in toluene. The scintillation effectiveness and ionization potentials of solutions and activators are presented. (W.H.K.)

20394 QUENCH-CORRECTION METHODS IN LIQUID SCINTILLATION COUNTING. Stanef, Ianca (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 10, 1213-27(1971). (In Rumanian).

Topics include the internal standard method, extrapolation methods, channel ratio method, external standard method, ^{57}Co as internal standard, ratio of the counts of external standard, balance quenching method, optical method, coincidence methods, amplification ratio method, and the Jordan Kazmar method. (43 references) (auth)

20395 ABSOLUTE METHODS FOR MEASUREMENT OF PURE BETA EMITTERS. Stanef, Ianca (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 8, 961-72(1971). (In Rumanian).

Topics include the 4π counter, internal gas counter, liquid scintillation counter, defined solid angle method, ionization chamber, and calorimetric methods. (72 references) (auth)

20396 ION-MOLECULE REACTIONS IN GEIGER-MUELLER DISCHARGES. Fredrickson, S. E. Jr.; Rathburn, D. W. (Midwestern Univ., Wichita Falls, Texas). Appl. Sci. Res. (The Hague) 24: No. 2-3, 209-12(Jun 1971).

In exploring the nature of a GM discharge a small amount of tritium was mixed with commercial Q-gas (1.3% n-butane and 98.7% helium). After operation the counter was found to be badly contaminated. Attempts to remove the activity failed to yield satisfactory results. An analysis of the gas mixture revealed that tritium activity is present in n-butane, with none being found in the expected decomposition products. An ion-molecule reaction involving n-butane is proposed to explain the results. (auth)

20397 APPARATUS FOR DETECTING FISSION PRODUCTS. Nelip, V. A.; Potekhin, I. S.; Radyvanyuk, A. M. Russian Patent 243,089. 5 May 1969. Filed 14 Jul 1967. (In Russian).

A device for indirectly measuring the fission products in a liquid or gas is described. An absorbent belt is drawn through the liquid and then passed in front of the window of a radiation detector where the decay products of the fission products are detected. (W.H.K.)

20398 APPARATUS FOR RECORDING RADIOACTIVE RADIATION. Vartanova, L. I.; Zherebin, E. A.; Krylov, A. I.; Polikarpov, V. I.; Yuzvuk, N. N. Russian Patent 243,093. 5 May 1969. Filed 24 Mar 1967. (In Russian).

The apparatus described comprises a sampler, a mechanically-powered belt, a belt-absorber, and a detector of radioactivity. In order to record the radiations of separated fission products coexisting with products of activation in a gas or aqueous carrier, a series of vessels containing chemical reagents is arranged between the sampler and the detector. The belt-absorber is caused to pass around a series of rollers and be immersed in each chemical reagent in turn. (K.S.W.)

20399 REDUCTION OF CHEMILUMINESCENCE IN BOTH REFRIGERATED AND AMBIENT TEMPERATURE LIQUID SCINTILLATION COUNTING. Kearns, D. S. (Picker Medical Manufacturing Div., North Haven, Conn.). Int. J. Appl. Radiat. Isotop.; 23: No. 2, 73-7(Feb 1972).

The problem of chemiluminescence in modern ambient-temperature liquid scintillation counters is described and compared with the same phenomenon previously observed in refrigerated systems. It was found that no substantial advantage was gained by cooling the chemical systems studied in a more expensive refrigerated scintillation counter. In addition, methods of reducing chemiluminescence by either neutralization or the addition of BHT are described. (auth) (UK)

20400 CALCULATED RESPONSE OF FILM BADGE AND FISSION FRAGMENT TRACK DOSIMETERS WITH INDIUM AND CADMIUM FILTERS TO INTERMEDIATE NEUTRONS. Gomaa, M. A. (Atomic Energy Establishment, Cairo). Atomkernenergie; 18: No. 4, 321-2(1971).

Neutron interaction with cadmium covered indium filters produces beta induced activity mainly due to intermediate neutrons. This activity may cause film blacking under the filter as well as track density loss when a cadmium fission fragment track dosimeter is used. The intermediate neutron dose may be estimated from the film blacking and track density loss, where the calculated response is found to be 1.22 net density/rem for the film badge and 190 track/cm^2/rem for fission fragment track dosimeter. (auth)

20401 ANALYSIS OF PULSES PRODUCED IN THE RECOVERY TIME OF G.M. COUNTER USING A TIME ANALYZER. Akutsu, Juichi (Inst. of Physical and Chemical Research, Wako, Japan); Hara, Koichi; Kanno, Kiyoshi. Rikagaku Kenkyusho Hokoku; 47: No. 4, 97-103(Jul 1971). (In Japanese).

By applying the probability theory to the time distribution of counting pulses appearing in the time analyzer, an expression for the resolving time of the G.M. counter is given. The results are compared in practice in the cases of Riken B2N, Aloka-2530B, -5780, -4225 and Amperex-200NB counters. Some interesting results have been shown in the time distribution curves obtained for these different counters. (auth) (Japan)

20402 ABSOLUTE FLUX MEASUREMENTS USING THE ACTIVITY RATIO TECHNIQUE. Sardina, Rafel H.; Plaza, Heriberto; Sasscer, Donald S. (Puerto Rico Nuclear Center, Mayaguez). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 18-19(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

20403 MEASUREMENT OF NOISE IN SEMICONDUCTOR NUCLEAR RADIATION DETECTORS. Zakharchuk, O. V.; Nikitin, B. A.; Fedoseeva, O. P. Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 6, 1080-2(Dec 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 6, 1230-2(Jun 1971).

The experimental determination of the spectral density of noise in silicon detectors is reported, and the relationship between this density and the current is studied. (W.H.K.)

20404 HIGH RESOLUTION SCINTILLATION SPECTRA OBTAINED WITH NANOSECOND PULSES OF 3 MeV ELECTRONS. Horrocks, D. L. (Argonne National Lab., Ill.). Photochem. Photobiol.; 15: No. 2, 239-44(Feb 1972).

A 3-MeV electron source from a pulsed Van de Graaff was used to excite cyclohexane solutions of 2,5-diphenyl-1, 3-oxazole (PPO) and 2-(4-isopropylphenyl)5-(4-biphenylyl)-1,3,4-oxadiazole (i-p-PBD). The scintillation spectra excited by electrons (measured at various solute concentrations to study self absorption) were identical with the spectra obtained from the photo-excitation of the first excited singlet level of the given solute. Variations in pulse duration did not change the shape of the measured spectrum. Results were obtained for electron pulses of 1, 3, 12, and 33 nsec. When the intensity of the pulse was altered from 200 to 800 mA, there was no measurable difference in the scintillation spectrum, but a measurable decrease in scintillation intensity. It was concluded that the only emissions measured were the transitions in the solute molecule from the S_1 energy level to the ground state vibrational levels. (UK)

20405 NEW NUCLEAR INSTRUMENTATION AND MEASURING TECHNIQUES: INTERKAMA 1971. Atomwirt., Atomtech.; 17: No. 1, 39-43(Jan 1972). (In German).

A survey of newer nuclear-electronic equipment is given for the Fifth International Congress with Exhibition for Measuring Techniques and Automation "INTERKAMA 71". Developments in reactor instrumentation (neutron detectors, cladding surveillance, and neutron flux measuring devices), radiation and contamination monitors, and industrial radiation equipment are summarized. In the industrial category are included density, thickness, and surface controlling apparatus, counters of several types, linear amplifiers, devices for continuously monitoring liquid level, dust measuring in gases, and radiation sources. (K.S.W.)

20406 GERMANIUM RADIATION DETECTORS WITH ION-IMPLANTED CONTACTS. Guseva, M. I.; Mansurova, A. N.; Sakharov, A. N.; Staritsin, K. V.; Khusainov, A. Kh. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 6, 1014-16(Dec 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 6, 1154-7(Jun 1971).

A study was made of the electrical properties of layers doped by bombardment of pure germanium with P^+, B^+, and As^+ ions of energy 30 keV. These ions were generated in an ILU-2 accelerator and the implanted dose was 1 to 1×10^{-4} $\mu C/cm^2$. It was found that, in unchanneled irradiation of germanium, temperatures ≥600°C were necessary to produce a doped layer free of radiation defects. However, the layers which were obtained by irradiation at 400°C could also be used to form high-quality p-n and n-n^+ junctions. Germanium γ-ray detectors of the p-i-n type were prepared. The p-type and n-type layers in these detectors were formed by ion implantation and the detectors were able to withstand a reverse voltage >1500 V at liquid nitrogen temperature. (auth)

20407 NUCLEAR METHOD FOR MEASUREMENT OF THE MINORITY-CARRIER DIFFUSION LENGTH IN SEMICONDUCTOR DETECTORS OF NUCLEAR PARTICLES. Zakharchuk, O. V.; Il'in, A. A.; Fedoseeva, O. P. Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 2, 250-3(Aug 1971).

Translated from Fiz. Tekh. Poluprov.; 5: No. 2, 293-8(Feb 1971).

A study was made of a nuclear method for measurement of the diffusion length of the minority carriers in the track of an ionizing particle in a surface-barrier detector of nuclear particles. Since the accuracy of the proposed method depends strongly on the accuracy in the measurement of the width of the space-charge region, two methods for measuring this width are given. Measurements were made on a number of silicon surface-barrier detectors. The results indicated that there was no correlation between the carrier lifetime in the track (plasma) and the resistivity of the original detector material or the carrier lifetime measured from the decay of the photoconductivity. (auth)

20408 PROGRESS IN CHERENKOV COUNTER DESIGN. Denisov, S. P. (Inst. of High Energy Physics, Serpukhov, USSR). pp 453-78 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The published literature for 1968–1970 on gas-filled Cherenkov detectors is reviewed. Threshold, multichannel, and differential counters are covered in the survey. (31 references) (K.S.W.)

20409 ACHROMATIC CHERENKOV COUNTER FOR 400- TO 700-MeV PROTONS WITH CALCULATED RESOLUTION OF ±3 MeV. Zrelov, V. P.; Kollar, D.; Pavlovich, P.; Ruzhichka, Ya.; Shulek, P. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 482-5 of Proceedings of the International Conference on Instrumentation for High Energy Physics. Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

An achromatic Cherenkov counter was designed for investigating quasi-elastic 660-MeV proton scattering by light nuclei. The system used a radiator, a ring prism, spherical and plane mirrors, a ring diaphragm, and a photomultiplier. The proton counter operated in the 400 to 700 MeV region. The degree of achromatization was determined for the wavelength limits of 3650 and 6563 Å. (1 figure, 1 table) (K.S.W.)

20410 DIFFERENTIAL CHERENKOV COUNTER WITH VELOCITY RESOLUTION OF UP TO 2×10^{-6}. Gorin, Yu. P.; Denisov, S. P.; Donskov, S. V.; (and others) (Inst. of High Energy Physics, Serpukhov, USSR). pp 486-8 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A gas-filled differential Cherenkov counter having a velocity resolution up to 2×10^{-6} for a length of 10 m is described. Its characteristics were studied in the beam of secondary negative particles from a 70-GeV accelerator with momenta of 35 and 45 GeV/c. The counter was positioned on a parallel segment of the magneto-optic channel where the angular divergence of particles did not exceed 0.5 mrad. The effectiveness of particle recording was measured as a function of the helium pressure within the counter. (2 figures) (K.S.W.)

20411 CONTROLLED GAS TARGET FOR STUDYING PARTICLE STOPPING. Varlamov, V. G.; Dobretsov, Yu. P.; Dolgoshein, B. A.; Rogozhin, A. M. (Moscow Engineering Physics Inst.). pp 800-2 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A gas scintillation counter, consisting of a target which gave rise to electroluminescence in a pulsed electric field, was developed for recording the stopping of particles in inert gases. The following gases were used to fill the target: He (16 atmospheres) + Xe (3.5 atm), Ne (40 atm) + Xe (1 atm), and Xe (16 atm). The composition of the gas fixed the effectiveness of scintillation and the intensity of electroluminescence. (2 figures) (K.S.W.)

Radiation Dosimeters

Refer also to abstract 20113.

20412 (CONF-700909–, pp 51-5) MEASUREMENT AND COMPUTATIONAL TECHNIQUES IN BETA DOSIMETRY. Mackin, James; Brown, Stephen; Lane, William (Stanford Research Inst., Menlo Park, Calif.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

A small encapsulated LiF beta dosimeter developed for use in biological-effects experiments was calibrated and tested in a series of laboratory experiments, including a uniform-volume-source exposure, a point-source exposure, surface-roughness exposures, and an environmental resistance test. The dosimeters were then used in cooperation with biological experiments being conducted by other investigators. These included a plant-community exposure, a corn-plot exposure, three wheat and potato exposures, and a field test of surface roughness. The measured data were then compared with calculated values, and, in general, agreement was found to be satisfactory. (auth)

20413 (DP-1277) PERSONNEL ALBEDO NEUTRON DOSIMETER WITH THERMOLUMINESCENT ^{6}LiF AND ^{7}LiF. Hoy, J. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan 1972. Contract AT(07-2)-1. 46p. Dep. NTIS.

A belt-mounted thermoluminescent neutron dosimeter (TLND) that measures body-reflected neutrons and relates them to dose equivalent was designed at Savannah River. The dosimeter contains thermoluminescent LiF chips (enriched in ^{6}Li or ^{7}Li), which are more easily read and accurately interpreted than nuclear emulsions previously used. The dosimeter responds to a much wider energy range of neutrons than nuclear emulsions and is as accurate as most neutron survey instruments for measuring continuous spectra from scattered neutrons. The directional sensitivity of the TLND is approximately the same as that of nuclear emulsions. When the TLND is exposed to monoenergetic neutrons above 1 MeV or to a high-energy neutron source in air at <200 cm, the response of the TLND is about one-third the

estimated dose equivalent at the surface of the body. With low-energy spectra, the TLND overresponds with a relative response <2. The sensitivity range of the TLND is from 10 mrem to 50,000 rem with no observed rate dependence up to 7×10^7 rem/sec. The TLND result is not affected by exposure to gamma radiation (with gamma-to-neutron dose equivalent ratios of 100:1), except at low neutron exposures. (auth)

20414 (LA-4832) FACTORS AFFECTING THE DESIGN OF ALBEDO-NEUTRON DOSIMETERS CONTAINING LITHIUM FLUORIDE THERMOLUMINESCENT DOSIMETERS. Hankins, Dale E. (Los Alamos Scientific Lab., N. Mex.). Jan 1972. Contract W-7405-eng-36. 17p. Dep. NTIS.

Albedo-neutron dosimeters are being considered as a replacement for the NTA film badge and for measuring the neutron dose from intermediate- and low-energy fast neutrons. Factors affecting the design of an albedo-neutron dosimetry system using ^{6}Li and ^{7}Li thermoluminescent dosimeters were studied. These factors include energy dependence, sensitivity, orientation with respect to the body, dosimeter-to-body distance, source-to-dosimeter distance, and the presence of shielding materials between the source and the dosimeter. The study did not involve a specific dosimeter design, so the data obtained can be used for most albedo dosimeters. Design variables included incorporation of several thicknesses of polyethylene in the dosimeter, location of the thermal neutron detectors at nine different positions in or on the dosimeter, and use of differing diameters and thicknesses of cadmium shields in the dosimeters. The results should enable one to design an albedo-neutron dosimeter for his own application or to evaluate a system already in use. Proper design of albedo-neutron dosimeters can eliminate many of the problems that have restricted or limited their usefulness, although it appears that the poor energy dependence which may limit their wide-spread application cannot be improved. (auth)

20415 PRINCIPLE OF A NEW SOLID STATE DOSIMETER: EXOELECTRON EMISSION DOSIMETRY. Fujimura, R. (Nara Univ. of Education, Japan). Genshiryoku Kogyo; 17: No. 9, 50-4 (Jul 1971). (In Japanese).

The fabrication and performance of exoelectron dosimeters are discussed. The dosimeter is fabricated by coating a small amount of exoelectron emissive material (usually BeO or $CaSO_4$) on the wall of GM tube cathodes. The measuring range is from 10^7 to 10^4 R. (TSS) (Japan)

20416 DOSE DISTRIBUTION OF LINAC RADIATION BY PHOTOGRAPHIC FILM. Noda, Hiroji; Ono, Yo; Umesaki, Noriyoshi (Kurume Univ., Fukuoka). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 10, 1-5(Jan 1971). (In Japanese).

A method for obtaining linac dose distribution using photographic film was examined. Exposed film of Kodak industrial type M was selected. Good results were obtained when the film face was placed parallel to the direction of the radiation beam. Isodose curves were plotted by an automatic isodensity recorder. (TSS) (Japan)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 21034 and 21928.

20417 (IEA-243) REFLECTIVITY OF A Ge NEUTRON CRYSTAL MONOCHROMATOR AND THE IEA-R1 REACTOR SPECTRUM MEASUREMENT. Fulfaro, R. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Jul 1971. 25p. Dep. NTIS (U. S. Sales Only).

The thermal-neutron spectrum of the IEA-R1 reactor was measured in the wavelength interval from 0.3 Å to 3.0 Å by using a neutron crystal spectrometer. A germanium single crystal in reflection was used as monochromator because the second-order reflections from its (111) planes are theoretically forbidden. The germanium crystal reflectivity employed in the analysis of the data was calculated for the first five permitted orders. An effective absorption coefficient of the crystal was used to perform the calculations instead of the macroscopic cross section of the element used in calculations performed by other authors. The spectrum count rate was corrected for higher-order contamination and parasitic reflections and processed in order to obtain the effective thermal-neutron spectrum as a function of wavelength. A Maxwellian-type equation was adjusted by least-squares fit to the experimental points between 0.7 Å and 2.9 Å. The experimental results were compared with a theoretical Maxwellian distribution, and the effective neutron temperature was found to be 351 ± 8°K, which is 45°K above the average moderator temperature of 306°K. (auth)

20418 (JAERI-1216) BOB 70: THE PROGRAMME CODE FOR ANALYSIS OF THE GAMMA-RAY SPECTRUM FROM THE Ge(Li) DETECTOR. Baba, Sumiko; Baba, Hiroshi; Okashita, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Sep 1971. 13p. (In Japanese). NTIS (U. S. Sales Only).

A data-analyzing code, developed for high-resolution spectra such as spectra from the Ge(Li) detector, is described. This code is built for FACOM 230-60 and is adjustable to medium-sized electronic computers. It includes the following functions; (1) data smoothing, (2) peak searching by means of the first derivative method, (3) conversion from the clock-time mode to the live-time mode, and (4) determination of the photopeak energy and intensity. For the analysis of a 2047-channel spectrum, the required memory size is 29k and the required time is at most 10 seconds as the CPU occupying time. Furthermore, a data-plotting subroutine is available, though fairly inefficient, which is built for the CALCOMP graphic plotter. In the case where data plotting with this subroutine is added, the code requires the additional 5k memory core and the additional 15 seconds CPU time. (auth) (Japan)

20419 (KFKI-71-66) RESOLUTION OF MOESSBAUER SPECTROSCOPY. Nagy, D. L.; Kulcsar, K. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1970]. 8p. (CONF-710947-3). Dep. NTIS (U. S. Sales Only).

From fourth international conference of the socialist countries on Moessbauer spectrometry; Dresden, Germany (20 Sep 1971).

Physical and mathematical methods for improving the resolution of Moessbauer spectroscopy are compared. The mathematical method based on the Fourier transformation seems to be rather advantageous. This method is very sensitive to the form of the filter function which is used to avoid false oscillations and noise in the transformed spectrum. A filter function of rather general form is proposed and its usefulness is demonstrated in the case of some iron-based dilute alloys [Fe(Al), Fe(Mo)], for which the satellites belonging to the 2nd and 3rd neighbors are resolved. (auth)

20420 INTERACTIONS OF Ge(Li) DETECTORS AND ION PUMPS. II. EFFECT OF INTRODUCED GASES. Fouarge, J.; Delporte, R. (Univ., Liege). Nucl. Instrum. Methods; 99: No. 1, 93-101(1972). (In French).

At relatively high discharge rates, titanium getter pumps release gases; some are very "active" on the surface current of Ge(Li) diodes. Addition of slight amounts of gases like H_2, CH_4, O_2 into the cryostat at the beginning of the pumping action can force the reverse current to pass through a minimum value in a controllable and reproducible way. In particular, the antagonistic action O_2 versus H_2 or CH_4 can be used. An interpretation of the phenomena is proposed. (2 figures, 1 table) (auth)

20421 MEANS OF INCREASING THE ACCURACY IN ANGULAR CORRELATION MEASUREMENTS. Karlsson, E. (Univ. of Uppsala). pp 27-66 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Some methods for improving angular correlation measurements are suggested. The topics discussed include corrections for deviations from ideal geometry, selection of the desired quanta, the efficiency of data collection, and numerical methods in the determination of angular correlation parameters. (J.W.R.)

20422 INTRASOURCE SCATTERING AND ABSORPTION EFFECTS ON $\gamma-\gamma$ ANGULAR CORRELATION MEASUREMENTS. Lopiparo, P. C.; Rasera, R. L. (Univ. of Pennsylvania, Philadelphia). pp 66-70 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Numerical calculations are performed for the effects of γ-ray scattering and absorption on measured angular correlations. These effects may be appreciable in extended solid samples of higher density and atomic number. The results of the calculations may be used to choose favorable source configurations and to correct data for the remaining attenuations. (J.W.R.)

20423 FIFTYSIX CHANNEL GONIOMETER. Gerholm, T. R.; Pettersson, B. G.; Bargholtz, C.; (and others) (Univ. of Stockholm). pp 70-4 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

A fifty-six channel goniometer for use in $\gamma-\gamma$ angular correlation studies is described. The device uses eight NaI(Tl) detectors between which all possible coincidence combinations are simultaneously recorded with a fast–slow technique. Measurements may be made in a time integral or differential mode. (J.W.R.)

20424 $\beta\gamma$ ANGULAR CORRELATION MEASUREMENTS ON FIRST FORBIDDEN β-TRANSITIONS. Wischhusen, R.; Behrens, H. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 315-18 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

An experimental setup which allows one to reduce the usual statistical and systematical errors in $\beta-\gamma$ angular correlation measurements considerably is described. The arrangement uses 4β counters in different positions and 2 periodically exchangeable γ counters. Some preliminary results on first-forbidden decays of ^{86}Rb and ^{198}Au obtained with the arrangement are reported. (J.W.R.)

20425 GAMMA SPECTROMETRY: MEASUREMENT METHODS IN HEALTH PHYSICS. Voicu, V. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 22: No. 4, 437-51(1970). (In Rumanian).

Gamma spectroscopy using NaI(Tl) detectors is discussed. Energy calibration, efficiency calibration, resolution, and background are discussed. Measurement techniques are considered including corrections for interference from identified nuclides; partially or completely overlapped photopeaks; the stripping method; the matrix method (simultaneous solution); and the graphical method. (W.H.K.)

20426 COMPUTER-COUPLED Ge(Li) SPECTROSCOPY IN NEUTRON ACTIVATION ANALYSIS OF SEMICONDUCTOR SILICON. Keenan, J. A.; Larrabee, G. B. (Texas Instruments, Inc., Dallas). Chem. Instrum.; 3: No. 2, 125-40(1971). (CONF-701017-6).

From fourteenth annual conference on analytical chemistry in nuclear technology; Gatlinburg, Tenn. (13 Oct 1970).

The spectrometer system developed consists of a Ge(Li) detector and a 4096-channel multichannel analyzer interfaced directly to a computer with 16,384 24-bit words. The restrictions imposed by a medium-sized core have been circumvented by performing the data reduction in successive steps which are called from a disk file while the data remain in core. Since the analyzer memory is not used to store data during reduction, new data can be acquired while data reduction is in progress. The disk file includes routines for energy calibration, efficiency calibration for each of the geometries used in counting, smoothing, and peak location and integration. The output options include linear or semilogarithmic plots of the spectra. Calibration in the energy region 40 to 1600 keV is done with a mixed source ^{57}Co, ^{137}Cs, and ^{60}Co. Since the samples are routinely irradiated under reproducible conditions in the same reactor, the flux can be derived from a single flux value obtained from a gold and cobalt monitor. Analysis of standard mixtures indicates an accuracy ranging from ±4.9 to ±7.5%, depending on the counting statistics. Silicon analyses using this system are compared to the more classical NaI(Tl) system. The increased Ge(Li) detector resolution makes possible analyses of silicon samples which could not be performed on a NaI(Tl) detector. (auth)

20427 DOUBLE MAGNETIC PRISM FOR A PRECISION BETA SPECTROMETER. Akhmetov, K. M.; Basin, L. A.; Bobykin, B. V.; (and others) (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1248-53(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1584-90(Aug 1971).

A magnetic prism is described in which pole tips of a high-permeability alloy are used; these are separated by gaps from the magnet yoke. This arrangement is intended to increase the two-dimensionality of the field. Calculations are given which show that the introduction of these gaps significantly corrects the deviation from two-dimensionality of the field associated with the finite permeability. To limit the fringing field the prism is made in the form of two identical magnets whose fringing fields balance each other far from the system. Near the gaps between the poles the fringing field is limited by a system of magnetic shields. Measurements show that in a beta spectrometer with this system the instrumental linewidth due to the deviation from two-dimensionality is less than $1.5 \cdot 10^{-5}$ of the dispersion. (auth)

20428 TRANSMISSION OF AN ELECTRON BEAM THROUGH A MAGNETIC PRISM. Basin, L. A.; Bobykin, B. V.; Davydovskii, V. Ya.; Kel'man, V. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1254-60(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1591-1601(Aug 1971).

Data are given that characterize the behavior of an electron beam in a magnetic prism having a high degree of field two-dimensionality; the properties of the electron image in the focal plane of a beta spectrometer in which this prism is the dispersive element are treated. The data are obtained by calculations based on the measured field distribution. The calculations are carried out to third order with respect to the distances of the trajectories from the central plane and the slope angles of these trajectories. It is shown that there are two ways in which the beta spectrometer can be tuned. The contribution of prism aberrations to the relative spectral-line width is determined, and it is shown that this contribution decreases significantly when a curved pickup aperture is used. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 21010 and 21044.

20429 (JINR-D-5805) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON INSTRUMENTATION FOR HIGH ENERGY PHYSICS, DUBNA, USSR, SEPTEMBER 8–12, 1970. Dzhelepov, V. P. (ed.) (International Union of Pure and Applied Physics. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]. Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 897p. (In Russian and English). (CONF-700902).

Separate abstracts were prepared for 101 of the 105 papers presented. The remaining 4 papers were previously included in NSA. The proceedings are bound in two volumes. (W.H.K.)

For abstracts of individual papers see: 20408–20411, 20436–20510, 21008–21010, 21037–21051, 21363, 21529, 22173, and 22174.

20430 (LA-4824, pp 137-42) RICE-UNIVERSITY OF HOUSTON EXPERIENCE WITH MWPC SYSTEMS. Phillips, G. C. (Rice Univ., Houston, Tex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The performance and use of multiwire proportional counter (MWPC) systems are described. The advantages, design, and operating characteristics of MWPC's are discussed, along with the electronic readout system. Small-angle multiple scattering of protons at 585 MeV and pions at 240 to 340 MeV/c by Al, C, Cu, and Pb was measured with a MWPC system and compared with the theories of Moliere and Nigram et al. There is a systematic deviation with Z between the data and the Moliere theory. Preliminary differential cross sections for small-angle π^{+-}-^{12}C scattering at 115, 167, and 241 MeV are presented. They show destructive interference below the (3,3) resonance and constructive interference above the (3.3) resonance. (7 figures, 1 table) (R.W.R.)

20431 (LA-4824, pp 143-4) TRIP REPORT: USE OF MWPCs BY THE SFM GROUP AT CERN. Martin, E. Ray (Los Alamos Scientific Lab., N. Mex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The use of multiwire proportional counters by the Split Field Magnet Group at CERN is discussed. The characteristics of these counters and the requirements which they must meet are given. The associated magnets and electronic systems are also considered. (R.W.R.)

20432 (LA-4824, pp 157-61) DECODING AND READOUT OF PWC UNDER VARIOUS EXPERIMENTAL REQUIREMENTS. Dhawan, S. (Yale Univ., New Haven, Conn. Gibbs Lab.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

Four different systems using proportional wire chambers are considered. The systems range up to 3000 wires. Schematic circuit and logic diagrams are included. Wire address coding is discussed. (8 figures) (R.W.R.)

20433 NUCLEAR ELECTRONICS. Blanc, Daniel. Que Sais-je Collection No. 1438. Paris; Presses Universitaires de France (1971). 126p. (In French).

The phenomena involved in particle detection are reviewed (charged or neutral particles, material and virtual particles). Physical detectors (using auxiliary electronics) and electronic detectors are briefly discussed: ionization chambers, counter tubes, scintillators, and Čerenkov counters. The electronic

circuits associated with the detectors are described. The utilization of an on-line computer for handling the data is envisaged. The devices used in dosimetry are briefly reviewed. (France)

20434 LOW TEMPERATURE PLANT FOR THE BIG EUROPEAN BUBBLE CHAMBER BEBC. Giger, U.; Pagani, P.; Trepp, C. (Sulzer Brothers Ltd., Winterthur, Switzerland). Cryogenics; 11: No. 6, 451-5(Dec 1971).

The 3.7 m bubble chamber, at present under construction for CERN, will hold 33.5 m^3 of liquid hydrogen and work in a field of 3.5 T. For cooldown and operation of the chamber and its superconducting magnet, a compound helium/hydrogen refrigeration plant has been chosen which has to fulfill, under normal operating conditions, the following cooling requirements: at 4.4 K – 1.5 kW and 2.5 g liq He s^{-1} – at 22 K – 25 kW. Special attention had to be paid to the cooldown of the magnet, in order to minimize the thermal stresses in the magnet and its containers. A description of the plant flow diagram is given. No cooling machinery is built into the hydrogen cycle; such machinery being concentrated on the helium side, where two pairs of high-speed oil-lubricated turbines are installed. The helium circuit is a modified Claude cycle, precooled by Stirling cycle machines. It produces the cold for the helium side, and also provides precooling for the hydrogen circuit, which is a simple Joule–Thomson cycle, precooled at approximately 80 and 40°K. The different modes of operation of the plant when used for cooldown and liquefaction, as well as the possibilities of emergency operation, are discussed and the advantages of the compound system are explained. (auth) (UK)

20435 BUBBLE CHAMBER FILM ANALYSIS. Kenyon, I. R. (Univ. of Birmingham, Eng.). Contemp. Phys.; 13: No. 1, 75-104(Jan 1972).

Bubble chamber film analysis is broadly the retrieval and interpretation of information on elementary particle interactions recorded on photographs of particle interactions in bubble chambers. A very brief account of bubble chambers is given to explain their usefulness as particle detectors. Essentially bubbles are formed along the tracks of all the charged particles involved in an interaction—a set of stereo-photographs is taken to record this information. The methods by which photographs are scanned (examined) for interactions of interest and the film images of tracks from such interactions are measured are described. The geometric reconstruction of the events from the measurements and the interpretation of reconstructed events using kinematic fitting procedures are discussed. When this stage of analysis is reached, events with the same interpretation (which involve the same reaction) are assembled and can be used to study that reaction. Such studies in elementary particle physics are discussed, and the role of film analysis in the detection and measurement of the quantum numbers of excited particle states for which the bubble chamber technique is an invaluable tool is emphasized. (auth) (UK)

20436 COMPUTER CONTROLLED SYSTEMS. Collins, George B. (Brookhaven National Lab., Upton, N. Y.). pp 3-15 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Some of the present and future uses of computers in high-energy physics experiments are reviewed. Particular application to a single spectrometer system consisting of wire chambers and scintillation and Cherenkov counters is discussed. (W.H.K.)

20437 COMPUTER-CONTROLLED DATA ACQUISITION SYSTEM FOR A WIRE SPARK CHAMBER EXPERIMENT. Aubert, J. J. (CERN, Geneva); Friend, B.; Hopson, B. (and others). pp 26-8 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A spark chamber system that was designed to study the $\Delta S = \Delta Q$ rule in K_{e3} decay is briefly described. Data are obtained from 36 wire spark chamber planes with readout of 25,000 cores, eight 16-bit registers receiving hodoscope patterns, a digital voltmeter reading the analyzing magnet current, and 20 scaters. A Varian Data Machines 620i computer is used. (W.H.K.)

20438 INSTRUMENTATION FOR SEARCHING FOR NEW HEAVY PARTICLES. Grishkevich, Ya. V. (Joint Inst. for Nuclear Research, Dubna, USSR); Krumshtein, Z. V.; Lyaiste, R.; (and others). pp 29-31 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

As an aid in the search for new heavy quasistable particles ($\tau \geq 10^{-7}$ sec) in the beam of negative particles of the Serpukhov accelerator, equipment was designed which would detect particles in the mass range 2 to 17 M_p under high loading conditions by light particles (π^-, K^-, $\bar{p}$). Particles were identified by mass, momentum, and velocity in the discrimination of light particles using Cherenkov counters. A time-of-flight spectrometer was employed, and the entire apparatus operated in conjunction with a BESM-3M computer. (K.S.W.)

20439 HODOSCOPIC EQUIPMENT FOR INVESTIGATING ELASTIC SCATTERING OF HIGH-ENERGY PARTICLES. Borisov, A. A.; Bugorskii, A. P.; Bushnin, Yu. B.; (and others) (Inst. of High Energy Physics, Serpukhov, USSR). pp 32-5 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Equipment was designed for the interval of particle pulses from 40 to 60 GeV/c with an accuracy of ±0.35%, and with a capacity of 10^6 events/hr. The hodoscope consists of counters based on the photomultiplier FEU-30. Each counter is supplied with a light diode which is activated by the pulse generator through a commutation system, preparing the system during absence of the beam. (K.S.W.)

20440 AUTOMATIC APPARATUS FOR HIGH-ENERGY EXPERIMENTS WITH ON-LINE COMPUTER. Bisello, D.; Centro, S.; Mulachie, A.; (and others) (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). pp 36-45 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The electronic circuitry being developed for a large volume magnetic spectrometer for experiments in Adone is described. The spectrometer consists of a large acceptance, high precision momentum analyzer, an optical spark chamber system, and trigger counter sets. The decisional macrologic, amplitude analysis, photomultiplier power control, the magnetic apparatus, and computer interface are discussed. (W.H.K.)

20441 TRACK ANALYSIS FOR THE SLAC WIRE SPARK CHAMBER SPECTROMETER. Beniston, M. J. (IBM Scientific Center, Palo Alto, Calif.); Budenaers, D.; Carnegie, R.; (and others). pp 46-8 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The method for momentum analysis of particle tracks in the magnetic spark chamber spectrometer at SLAC is briefly described. (W.H.K.)

20442 SYSTEM FOR ON-LINE ANALYSIS OF WIRE SPARK CHAMBER DATA. Beniston, M. J. (IBM Scientific Center, Palo Alto, Calif.); Clemens, B. A.; Armstrong, G.; (and others). pp 49-51 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The MIDAS II programming system to monitor, collect, and analyze data from the wire spark chamber spectrometer at SLAC is described. The MIDAS II on-line analysis system was written for the SLAC IBM 1800 and IBM 360/91 computers coupled by a data link. (W.H.K.)

20443 AUTOMATIC CALIBRATION OF EXPERIMENTS: THE ACE SYSTEM. Zacharov, B.; Peatfield, A. C. (Daresbury Nuclear Physics Lab., Eng.). pp 52-9 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A computer-controlled CAMAC system for automatic calibration of parameters in photomultiplier counter channels is described. Calibrations such as setting the correct values of EHT on photomultiplier tubes, setting discrimination thresholds, or determining the appropriate value of delay in a channel are performed automatically. (W.H.K.)

20444 DESCRIPTION OF A SCINTILLATION COUNTER DATA ACQUISITION SYSTEM FOR USE WITH THE SLAC 40" HYDROGEN BUBBLE CHAMBER. Smart, W. M.; Friday, R. G.; Leith, D. W. G. S.; Moriyasu, K. (Stanford Linear Accelerator Center, Calif.). pp 60-5 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A data acquisition system consisting of time-of-flight scintillation counters, associated electronics, and a PDP-9 computer, has been developed for use with the SLAC 40 inch hydrogen bubble chamber (HBC) and is currently being installed. The system is designed to give optimum timing resolution subject to the limitations of the current HBC design, but it may also be used to trigger the HBC camera only for a certain class of events. A general description of the system, a discussion of the major factors affecting the timing resolution, and the expected results for use of the system in a K_2^0 beam are given. (W.H.K.)

20445 TRIGGERING OF SPARK CHAMBER FOR ELASTIC π^--p SMALL-ANGLE SCATTERING AT 2 TO 6 GeV. Vorob'ev, G. G.; Likhachev, M. F.; Nomofilov, A. A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). pp 66-9 of Proceedings of the International Conference on Instrumentation for High Energy Physics. Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The system described can effect selective triggering of a spark chamber and may be used in the measurement of the differential elastic scattering cross section for $\pi^- + p$ reactions in π^- meson energies of 3 to 6 GeV. The kinematic parameters of the $\pi^- + p$ interaction are determined with a filmless spark spectrometer connected to a computer. A study of the angular distribution of particles scattered in a hydrogen target showed that the number of events of elastic scattering in the angular interval of 5 to 20 mrad was small in comparison with the number of background events. The effectiveness of the triggered system is shown as a function of the scattering angle of pions. (K.S.W.)

20446 MAGNETIC SPECTROMETERS. Panofsky, W. K. H. (Stanford Linear Accelerator Center, Calif.). pp 73-112 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The magnetic elements in magnetic spectrometers for analysis of high-energy particles emanating from a target where emphasis is placed on measuring the production angles and momenta are discussed. Both small aperture, single arm spectrometers and wide aperture spectrometers are considered. (W.H.K.)

20447 THREE-METER MAGNETIC SPECTROMETER WITH SPARK CHAMBER. Baloshin, O. N.; Blagorodov, A. M.; Borodin, Yu. A.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). pp 113-20 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A magnetic track spectrometer was designed with a slotted upper yoke of the magnet which provides a larger magnetic field at the same power input. Multigap spark chambers were positioned under the yokes and could be photographed by three cameras through a system of mirrors. The magnet itself measures $50 \times 100 \times 300$ cm, weighs about 140 tons, normally consumes 1.0 MW of power, and furnishes an average field of 16.7 kilogauss. The spark chambers and optical system are fully described. (K.S.W.)

20448 SUGGESTION BY H. L. ANDERSON FOR A HIGH ENERGY MAGNETIC SPECTROMETER. pp 121-2 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A proposal to use the 170 inch magnet of the University of Chicago cyclotron (which will probably be shut down) in a spectrometer to measure both the fast forward particle and the low momentum recoil at large angles is outlined. The incident beam would impinge on a hydrogen target placed just inside the magnetic field region. Fast negative secondaries at angles down to 0° would be bent by the magnetic field into an external telescope detector. Incident beam particles (p or π^+) which did not interact in the target would be bent in the opposite direction to allow a neutral particle detector to be placed in the 0° position. Recoil protons with kinetic energies <450 MeV and emitted at laboratory angles near 90° would be retained in uniquely defined circular orbits in the magnet so that the proton angle and momentum could be determined by an arrangement of three or more proportional chambers in the magnet. (W.H.K.)

20449 EFFECTIVE MASS SPECTROMETERS. Martin, M. B. (CERN, Geneva. Univ. of Geneva). pp 125-43 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Examples of wide aperture multiparticle analyzers for high statistics counter experiments are described including the CERN–IHEP Boson Spectrometer, the BNL Multiparticle Magnetic Spectrometer System, and the CERN OMEGA Spectrometer. (W.H.K.)

20450 RECENT EXPERIENCE WITH THE DOUBLE VEE MAGNETIC SPECTROMETER. Ozaki, S.; Cheng, D.; Foley, K. J.; (and others). (Brookhaven National Lab., Upton, N. Y.). pp 144-9 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The Brookhaven double-armed magnetic spectrometer is described. The spark chambers, scintillation counter hodoscopes, and data acquisition systems are discussed, and examples of interactions that can be studied with the setup are listed. (W.H.K.)

20451 NOVEL MISSING MASS SPECTROMETER AT THE PRINCETON-PENNSYLVANIA ACCELERATOR. Brody, H. (Univ. of Pennsylvania, Philadelphia); Groves, E.; Van Berg, R.; (and others). pp 150-2 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A simple missing mass spectrometer at the Princeton–Pennsylvania Accelerator for studying the $p + d \rightarrow {}^3He + MM$ interaction is described. The experiment takes advantage of the Jacobian peak method where it is possible to obtain a large momentum bite and still get a very precise value of missing mass by measuring only the angle of the ^3He with great precision. (W.H.K.)

20452 PROGRESS OF SUPERCONDUCTING SYSTEM APPLIED IN HIGH ENERGY PHYSICS. Schmeissner, F.; Haebel, E. U. (CERN, Geneva). pp 155-66 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Problems encountered in the development of superconducting magnets for high energy physics experiments are discussed, and progress in the development of big detector magnets, beam handling magnets, and superconducting field shielding tubes is outlined. (W.H.K.)

20453 MPI-VU MAGNET AND EXPERIMENTAL PROGRAM. Roos, C. E. (Vanderbilt Univ., Nashville). pp 167-72 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The Max Planck Institute–Vanderbilt University (MPI–VU) magnet, which is a large superconducting solenoid, is described. The magnet will be used at CERN in the Hyperon Bubble Chamber (HYBUC) and at Brookhaven in the Spark Grid Chamber (SGC). The magnet is a composite system with an inner high field magnet wound with Nb_3Sn and an outer magnet using NbTi. The central field is designed to exceed 110 kG, and the minimum room temperature bore is 6 inches. The inner coil produced a 43 kG field and the highest available external field was 60 kG. (W.H.K.)

20454 FILMLESS TRACK DETECTORS. Golutvin, I. A. pp 185-216 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A review of spark chambers and associated equipment for use with accelerators is presented. The parameters of wire spark chambers are given in detail, television techniques are described,

and the operation of a number of proportional chambers is outlined in tabular form. (53 references.) (K.S.W.)

20455 SOME RESEARCH ON THE MULTIWIRE PROPORTIONAL CHAMBERS. Charpak, G. (CERN, Geneva). pp 217-50 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Progress on the development of large multiwire proportional counters at CERN is outlined. The efficiency and the space and time resolutions are discussed. Detection properties of multiwire proportional counters using a filling gas mixture of argon + isobutane + freon-13 B1 are studied. (W.H.K.)

20456 LARGE MULTIWIRE PROPORTIONAL CHAMBER SPECTROMETER. Dieperink, J. H. (CERN, Geneva); Steffen, P.; Steinberger, J.; (and others). pp 251-6 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A large multiwire proportional chamber spectrometer for detecting the charged decay modes of the neutral kaon in the momentum interval 5 to 12 GeV/c for a decay path of ~25 K_s lifetimes, at a maximum data taking rate is described. Performance characteristics are listed. (W.H.K.)

20457 SOME DEVELOPMENTS AND TEST RESULTS OF MULTIWIRE PROPORTIONAL CHAMBERS (MWPC). Amato, G. (CERN, Geneva); Chesi, E.; Declais, Y.; Seguinot, J. pp 257-64 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A description of the main characteristics of a set of multiwire proportional chambers to be used in a measurement of the $K^- + n$ elastic angular distribution between 1.2 and 2.4 GeV/c to be performed at CERN is given. Characteristics include a spatial resolution of ±1 mm, a time resolution of 50 ns, an electronic threshold of 0.5 mV, and a dead time per wire of 1 μs. (W.H.K.)

20458 CODING SYSTEM FOR MULTIWIRE PROPORTIONAL COUNTERS. Bonazzola, G. C. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin); Bressani, T.; Chiavassa, E.; Tricomi, V. I.; Rubbia, C. pp 265-9 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Electronics for a pulse coding system for multiwire proportional counters is described. (W.H.K.)

20459 PROP-SPARK HYBRID CHAMBER: A DIGITAL DETECTOR OF SHORT RESOLVING TIME, FAST RECOVERY, AND CONVENTIONAL READOUT. Fischer, Joachim; Shibata, Shinkichi (Brookhaven National Lab., Upton, N. Y.). pp 270-7 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The hybrid chamber consists of a proportional mode wire chamber without amplifiers. After a synchronizing electron drift delay, the avalanches are read out by a narrow gap digital spark chamber pulsed on selected events. The chamber is about ten times faster than ordinary spark chambers. Resolving time is ~75 nanoseconds (fwhm); recovery time after spark is <80 μsec. Efficiency is close to 100%. Spatial resolution, inexpensive readout and construction are similar to that of conventional digital spark chambers. (auth)

20460 USE OF SPARKOSTRICTION IN AN EXPERIMENT. Cence, R. (Univ. of Hawaii, Honolulu); Jones, B.; Morgado, R.; (and others). pp 278-80 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The construction, operation, and efficiency of a spark chamber based on the principle that the shock wave of a spark on a wire will produce an acoustic pulse on it (sparkostriction) are described. The chambers were built to measure momentum spectra of the final particles in $K^+ \rightarrow \pi^+ + \pi^- + e^+ + \nu$ decays. The chambers were operated in a magnetic field of 7 to 9 kG. (W.H.K.)

20461 EVIDENCE FOR THERMAL NATURE OF SPARKOSTRICTION. Bichara, M. R. E.; Blecha, O.; Jauch, K.; Maeder, D. (Univ. of Geneva). pp 281-3 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

An experiment to study the sparkostrictive effect and to discriminate between electrical and non-electrical effects is described. The signals produced in fine wires by a Q-switched 5 MW laser were measured, and preliminary conclusions indicate that thermostriction is the main effect contributing to the sparkostrictive phenomenon. (W.H.K.)

20462 CYLINDRICAL WIRE SPARK CHAMBERS. Aubert, J. J. (CERN, Geneva); Niebergall, F.; Willitts, T. R.; (and others). pp 284-6 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A system of cylindrical wire spark chambers used in an experiment on the validity of the $\Delta S = \Delta Q$ rule in K^0_{e3} decay is described. The $K^+ + p \rightarrow K^0 + p + \pi^+$ interaction was used. (W.H.K.)

20463 ELEMENTARY PARTICLE DETECTORS WITH CONDENSED MEDIA AND ELECTRON CONDUCTANCE. Golovanov, L. B.; Golutvin, I. A.; Zel'dovich, A. G.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). pp 287-90 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The spectrometric and recording properties of Ar- and Xe-filled ionization chambers were studied. Specifications are given for a liquid or solid Ar plane-parallel chamber with circular electrodes. The value of the most probable ionization loss ($\epsilon_{prob.}$) by π^--mesons was determined as a function of the intensity of the field for solid Ar, with an interelectrode distance of 7.5 mm. The spectrum of ionization loss for a liquid Ar chamber had the typical form of a Landau curve. Similar results are reported for Xe-filled chambers. (K.S.W.)

20464 CONTROLLED RECORDING OF IONIZED PARTICLE TRACKS IN CONDENSED MEDIA. Dolgoshein, B. A.; Lebedenko, V. N.; Rodionov, B. U.; Miroshnichenko, V. P.; Kruglov, A. A. (Moscow Engineering Physics Inst.). pp 291-6 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

An electronic method was investigated for recording tracks in liquid Ar and Xe. With a field of 10 kV/cm practically all electrons will be expanded from the track of a relativistic particle. The coefficient of diffusion of hot electrons in an electric field of intensity 10 kV/cm in liquid Ar was close to 1 cm^2/sec. The method is based on electron emission from a liquid into a gas with resulting recording of the electron in the gas. The emission liquid chamber is designed so that electrons drift in a homogeneous electric field to the surface of the liquid and emerges into the gas phase (50% Ar, 50% Ne). A variant of the liquid emission chamber is also described. (K.S.W.)

20465 LIQUID ARGON PROPORTIONAL COUNTER. Kushnirenko, E. A.; Chilingarov, A. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 297-300 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A liquid argon counter was designed for detecting proportional electron multiplication formed by particle injection in liquid Ar in a constant electric field of about 10^6 volt/cm intensity. A cylindrical copper shell contains a 4 μ diameter filament stretched along its axis (Cu-coated W) which is insulated from the shell. This unit is positioned in a hermetically-sealed, thermally-insulated glass vessel which in turn is cooled in liquid nitrogen. Testing of the counter with ^{60}Co and ^{137}Cs gamma quanta and with Compton electrons is described. (K.S.W.)

20466 USE OF HODOSCOPIC PHOTOMULTIPLIERS IN CROSSED FIELDS FOR RECORDING HIGH-ENERGY PARTICLES. Vishnevskii, N. K.; Krasnokutskii, R. N.; Lapshin, V. G.; (and others) (Inst. of High Energy Physics, Serpukhov, USSR). pp

305-20 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Electron drift in crossed magnetic and electric fields is the basis of a "hodoscopic photomultiplier", the design for which has previously been reported. Results obtained in using this apparatus are discussed and are organized under the following topical headings: scintillation hodoscopes on the basis of hodoscopic photomultipliers, and obtaining information with gas discharge chambers, either spark or proportional types. Light yields in the chambers were studied as a function of the quantity of particles passing through them during a cosmic ray shower. The disadvantages of Cherenkov chambers (designed for recording Cherenkov radiation by means of an electron-optical converter) in connection with accelerator beams are their resolution time of 10^{-6} to 10^{-5} sec, and the loss in the optical part of the system. (K.S.W.)

20467 ADVANCES IN STREAMER AND SPARK CHAMBERS. Sherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 323-38 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Progress in the fields of streamer and spark chambers is reviewed. A classification is given for operating modes of chambers with large discharge intervals. Discharge studies and time characteristics in streamer chambers are examined. Pertinent accounts of chamber loading are given regarding the nature and pressure of the gas. The use of the streamer chamber as a detector and for the measurement of ionization properties and charged particle pulses with high accuracy is described. (38 references.) (K.S.W.)

20468 STREAMER CHAMBER AS AN IONIZATION SPECTROMETER FOR HIGH-ENERGY PARTICLES. Davitsenko, V. A.; Dolgoshein, B. A.; Somov, S. V.; Starosel'tsev, V. N. (Moscow Engineering Physics Inst.). pp 339-47 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The relativistic increase of the ionization loss in a gas suggests the use of a streamer chamber as an ionization spectrometer in the energy region $10 < E/Mc^2 \leq 300$ to 500. Results are adduced from the literature which demonstrate the relativistic growth of specific primary ionization as measured in a streamer chamber at various gas pressures of He, Ne, and He + Ne. (K.S.W.)

20469 STREAMER CHAMBER FOR MEASUREMENT OF IONIZATION. Eggert, K.; Guerich, W.; Hermens, K.; Stolze, C. (Technische Hochschule, Aachen). pp 348-54 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The chamber configuration, Marx generator and pulse shaping network, optics, and data analysis of a streamer chamber for measuring the ionization of elementary particles are briefly discussed. (W.H.K.)

20470 OPERATION OF THE DESY STREAMER CHAMBER. Eckardt, V.; Ladage, A. (Deutsches Elektronen-Synchrotron, Hamburg). pp 355-61 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

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A million pictures have been made with the DESY streamer chamber in a photoproduction experiment. A description of the streamer chamber with a liquid hydrogen target in the high voltage field is given. Some problems of high voltage stability, of direct photography, and of ionization measurements are discussed. Some details on experiences with short memory times and resolution data are given. (auth)

20471 ONE-METER STREAMER CHAMBER WITH INTERNAL GAMMA CONVERTER. Vardenga, G. L.; Zhuravleva, M. S.; Makarov, L. G.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). pp 362-5 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The SKM-100 facility which operates with a beam of slow K^0_L-mesons in the synchrophasotron is described. The basic unit of the SKM-100 is a streamer chamber $100 \times 60 \times 16$ cm^3 with a gamma converter in the working space. The advantages peculiar to the SKM-100 are: operation at maximum intensity of the synchrophasotron, use of the converter allows observation of electron-positron pairs from γ quanta conversion, high start-up effectiveness for the majority of decay processes, and simplicity and universality of start-up system in recording almost all rare K^0-meson decays and interaction products. (K.S.W.)

20472 INVESTIGATION OF STREAMER CHAMBER CHARACTERISTICS. Rudenko, N. S.; Smetanin, V. I. (Tomsk Polytechnic Inst., USSR). pp 366-8 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The optimal parameters of the high voltage supply impulse were determined through an investigation of the characteristics of a streamer chamber using high speed photography in conjunction with a type ZIM-2 electron–optical shutter and light amplifier. Photography of the particle track began with the avalanche phase and ended when the streamers spanned the entire gap. The streamer region of chamber operation was analyzed by a time (nsec) vs field intensity (kV/cm), and the resulting curves represent the limits of the streamer range of chamber operation and suggest an asymptotic approximation to certain values during an increase or decrease of the field intensity. (K.S.W.)

20473 ELECTRON-OPTICAL INVESTIGATION OF INCLINED SPARK FORMATION IN A SPARK CHAMBER. Rudenko, N. S.; Smetanin, V. I. (Tomsk Polytechnic Inst., USSR). pp 369-71 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

An investigation of the processes occurring at an electric breakdown along the trajectory of particles in a wide-gap spark chamber was carried out by means of high-speed photography using an electron-optical shutter (type Zim-z) and a light amplifier. The system allowed photographing the particle trace at definite moments from the stage of development of separate electron avalanches till its merging and formation of an inclined spark channel. Typical films of an inclined spark registered at successive moments of time are shown. (W.H.K.)

20474 STABILIZED HIGH VOLTAGE GENERATOR OF NANOSECOND PULSES FOR A LARGE STREAMER CHAMBER. Vorob'ev, A. A.; Rudenko, N. S.; Tsvetkov, V. I.; Kozlov, M. I.; Yudin, A. F. (Tomsk Polytechnic Inst., USSR). pp 372-3 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Circuitry using a three-electrode discharger is proposed for attaining maximum stability of pulse supply for feeding a streamer chamber. Within the limits of error, variations in pulse amplitude or in track width were not observed. The feed supply from the Arkad'ev–Marks generator was stabilized to about 1%. (K.S.W.)

20475 MEASUREMENT OF MOMENTUM SPECTRUM OF K^0-MESONS USING A WIDE-GAP SPARK CHAMBER. Avakyan, K. M.; Asatiani, T. L.; Zhirova, L. A.; (and others) (Erevan Physics Inst.). pp 374-8 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Apparatus is described with which the cross section of photomeson production and the momentum spectrum of K^0 mesons can be measured. In this apparatus a beam of neutral particles, produced in an aluminum target at an angle of 10° to the γ beam, passes through a collimator and is purified of charged particles with a magnet. A 20-cm thick lead plate filters the high energy γ quanta. Two identical wide gap spark chambers ($40 \times 80 \times 25$ cm^3) serve as K^0-meson detectors. The error in pulse measurement is reported to be 1.0 to 1.5%. This accuracy encourages the study of photoproduction processes in a hydrogen target and the separation of various channels of K^0-meson photoproduction in reactions of the type $\gamma + p \rightarrow K^0 + Y$. (K.S.W.)

20476 INVESTIGATION OF WIDE GAP SPARK CHAMBERS AT LOW SUPPLY VOLTAGES. Avakyan, K. M.; Aivazyan, R. B.; Krishchyan, V. M.; Matevosyan, E. M. (Erevan Physics Inst.). pp 379-81 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

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A series of measurements was conducted with a double gap chamber (2 × 15 cm) filled with pure neon at 700 torr pressure and at the operating voltages of 1.5 to 10 kV/cm. A chamber with an operating area of 20 × 15 cm was exposed to 300 MeV cosmic rays. The circuitry permitted feeding high voltage pulses without a steep drop of the front (1.5 nsec) and allowed one to judge the amplitude of the applied impulses with high accuracy. The results indicated that even with an electric field of 1.5 kV/cm a wide gap spark chamber complies with all requirements of a track detector of particles. (K.S.W.)

20477 PRODUCTION OF HOLOGRAMS OF AN ELECTRIC DISCHARGE WITH A STREAMER CHAMBER IMITATOR. Stabnikov, M. V.; Tombak, M. Sh. (Ioffe Inst. of Physics and Tech., Leningrad). pp 382-3 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The holographic method may be used for gathering information on an electrical discharge under conditions of low luminosity. Equipment was designed to investigate this possibility, which consisted of a laser with electro-optical modulation and a mock-up of a discharge chamber with a variable spark gap. A special generator of short high voltage pulses was used to break down the spark gap. Results with this equipment indicate that the holographic method of recording an extended spark discharge may be used for obtaining information from a streamer chamber and spark track chamber with a weakly luminescent discharge. (K.S.W.)

20478 LOCALIZATION OF CHARGED PARTICLE TRAJECTORIES IN HIGH PRESSURE SPARK CHAMBERS. Daion, M. I.; Lobkovskii, B. S.; Merzon, G. I. (Lebedev Inst. of Physics, Moscow). pp 384-6 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The accuracy of localizing the trajectory of a charged particle was investigated in a high pressure spark chamber filled with Ar and alcohol vapor. The chamber consisted of three separate equally-spaced spark gaps with interelectrode distances of 0.5 ± 0.05 mm located in a hermetically sealed vessel. From the experimental data, conclusions were drawn regarding the accuracy of localization of a trajectory: it is proportional to the gas pressure, and it increases with the amplitude of the high voltage pulse. (K.S.W.)

20479 DETECTION OF GAMMA QUANTA AND ELECTRONS AT HIGH ENERGIES. Govorkov, B. B. (Lebedev Inst. of Physics, Moscow). pp 389-413 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A review of detecting equipment for high energy γ quanta and electrons with emphasis on total absorption spectrometers of the scintillation and Cherenkov types is presented. Laminated detectors ("sandwich") for recording electrons and photons are a recent development, and their selectivity, energy measurement, and geometrical characteristics are discussed. (48 references.) (K.S.W.)

20480 ELECTRON ENERGY MEASUREMENT WITH A SHOWER SPECTROMETER. Dunaitsev, A. F.; Ivan'shin, Yu. I.; Kakauridze, D. B.; (and others) (Inst. of High Energy Physics, Serpukhov, USSR). pp 414-18 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A new method of measuring the energy of electrons and γ-quanta by the intensity of the secondary particles in the region of a shower maximum is based on the shower characteristics formed in matter by high energy electrons and photons. The resolving power of this technique was investigated in the electron beam of a proton synchrotron. Recording of showers formed by electrons in a K2 converter was accomplished by two types of detectors: a lead-glass Cherenkov unit and a four-layer scintillator "sandwich" type. (K.S.W.)

20481 USE OF THALLIUM-BASED CRYSTALS IN CHERENKOV SHOWER SPECTROMETERS. Varfolomeev, A. A.; Glebov, V. I.; Denisov, E. I. (Inst. of Atomic Energy, Moscow). pp 436-9 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Mixed thallium chloride-bromide crystals were investigated as a substitute for lead glass as a radiator in Cherenkov shower spectrometers. Pertinent properties are: density, 7.13 g/cm^3; critical energy 9.2 MeV, threshold of Cherenkov radiation for electrons, 50 keV, index of refraction, 2.3. Experimental results show that such Tl compounds possess certain advantages over lead glass in spectrometers. (K.S.W.)

20482 SCINTILLATION DETECTOR FOR 0.7- TO 2.5-GeV ELECTRONS AND PHOTONS. Anokhin, M. V.; Belyakov, E. S.; Bernshtein, L. I.; (and others) (Erevan Physics Inst.). pp 440-3 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

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A shower detector was constructed of five scintillation counters enclosed in a light-tight housing. Matching photomultipliers were carefully selected. The calibration of the shower detector in the secondary beam of electrons of a synchrotron is described and the results are discussed. (K.S.W.)

20483 OPTIMUM PARAMETERS OF A SHOWER CHERENKOV SPECTROMETER. Bekrenev, V. S.; Kruglov, S. P.; Shchegel'skii, V. A.; Shchetkovskii, A. I. (Ioffe Inst. of Physics and Tech., Leningrad). pp 444-6 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

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Theoretical and experimental investigations were conducted on the characteristics of a Cherenkov shower spectrometer with a lead glass radiator in order to obtain the optimum parameters for the energies of primary electrons and γ quanta up to one GeV. The results provided an absolute value of the light yield, assurance of linearity over the prescribed energy range, and radiator thickness for optimum resolving power of the spectrometer. (K.S.W.)

20484 THIN-WALLED SPHERICAL HIGH PRESSURE IONIZATION CHAMBER. Arkatov, Yu. M.; Vatset, P. I.; Voloshchuk, V. I.; Khodyachikh, A. F. (Physical-Technical Inst., Kharkov). pp 447-9 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A spherical ionization chamber of 0.5 mm thick Duralumin about 100 mm in diameter, and containing a 10 mm Al sphere electrode at its center secured by a Kapron (similar to Nylon) tension wire was studied. An Ar (90%)-CO_2 mixture was used to fill the chamber to a pressure of 5 atmospheres. The volt-ampere characteristics of the thin-walled ionization chamber were determined. Reliable operation over a period of years in gamma quanta monitoring is reported. (K.S.W.)

20485 TRANSITION RADIATION AND ITS USES IN DETECTORS OF ULTRARELATIVISTIC PARTICLES. Alikhanyan, A. I. (Erevan Physics Inst.). pp 491-508 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

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Photons of relativistic x radiation may be obtained in a sufficient number for use in detectors of transition x radiation. The intensity of x transition radiation is a linear function of the energy of primary particles, in agreement with Garibyan's theory. Recording of photons and primary particles in a streamer chamber may be used for particle identification in jets and stars at energies of 200 GeV and greater. (12 figures, 2 tables) (K.S.W.)

20486 HIGH ENERGY PARTICLE IDENTIFICATION BY TRANSITION RADIATION. Alikhanyan, A. I.; Ispiryan, K. A.; Kankanyan, S. A.; Oganesyan, A. G.; Tamanyan, A. G. (Erevan Physics Inst.). pp 538-41 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

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A laminated medium in which charged particles generated transition radiation was placed in a container with a gas absorber. The transition x radiation with energies equal to or greater than the absorption edge of the atoms of the gas absorber produced a characteristic radiation which was recorded by 16 CsI(Tl) scintillators. The effectiveness of electron recording increased sharply with an increase in their energies. As long as the number of photons of transition radiation depends on $\gamma = E/mc^2$, then the range of electron energies corresponds to the π-meson momentum range of 100 to 1000 GeV/c. (2 figures) (K.S.W.)

20487 INVESTIGATION OF TRANSITION RADIATION WITH A SPARK CHAMBER. Alikhanyan, A. I.; Garibyan, G. M.; Lorikyan, M. P.; Shikhlyarov, K. K. (Erevan Physics Inst.). pp 542-7 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

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An investigation was made of transition radiation in porous materials and laminated media, and some preliminary results are given on radiation in the x-ray region which is formed during the passage of extremely relativistic electrons through a crystal. A monochromatic electron beam was passed through an aperture in a scintillation counter, through a target-radiator, and finally recorded together with the transition x quanta (produced in the target) in a streamer chamber containing a 10% Xe addition. This was found to be a highly sensitive detector. Porous materials function effectively as radiators of transition radiation. The equipment described has the ability to separate light particles from heavy ones; several such units in series will operate as a detector for identifying e, π, K, or p at ultrarelativistic energies. (4 figures) (K.S.W.)

20488 SILICON DETECTORS TARGET FOR COHERENT PRODUCTIONS ANALYSIS. Bellini, G.; diCorato, M.; Manfredi, P. F.; Vegni, G. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). pp 567-71 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

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By using a laminated Si detector–target, coherent events can be separated from incoherent ones with good efficiency. The device was used in connection with an experiment in which 3π charged systems coherently produced were studied with a negative pion beam at 15 GeV/c. Resulting energy distributions of recoiling nuclei are given. (2 figures) (R.W.R.)

20489 BUBBLE CHAMBER DEVELOPMENT. Nikitin, S. Ya. (Inst. of Theoretical and Experimental Physics, Moscow). pp 615-20 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

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Progress in the technology of bubble chambers is reviewed. The newer chambers have large volume requirements, lessened distortion of the tracks, and increased intensities of the magnetic fields. The two huge bubble chambers are briefly described: the 12-foot chamber at Argonne Nat. Lab. and the 4.5-meter "Mirabelle" with a 20,000 gauss magnet at Serpukhov. Other large bubble chambers are noted, and new uses are discussed. (K.S.W.)

20490 PRESENT STATUS OF THE BIG BUBBLE CHAMBER MIRABELLE. Prugne, P. (CEN, Saclay, France). pp 621-39 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A general description of Mirabelle is given. During technological and physics tests 50,000 photographs were taken and 250,000 expansions occurred. Some minor difficulties were encountered, but they were easily overcome and did not do much to influence the progress of the tests. Optimum operating parameters were determined, and it appears that optical inhomogeneities of the liquid during expansions are lower than those in previous chambers. The proposed research program for Mirabelle at Serpukhov is outlined. (11 figures) (R.W.R.)

20491 STATUS OF THE HUGE LIQUID HYDROGEN CHAMBER. Fields, T. (Argonne National Lab., Ill.). pp 640-56 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The design features of the ANL 12-ft hydrogen bubble chamber are generally reviewed, including thermodynamic considerations; considerable care was exerted to minimize the amount of parasitic boiling within the chamber during expansion. The planned and actual construction schedules and fabrication costs are given, along with the results of chamber testing and future plans. (9 figures, 2 tables) (R.W.R.)

20492 NAL 15-FOOT BUBBLE CHAMBER AND THE USE OF TRACK SENSITIVE TARGETS IN NEUTRINO EXPERIMENT. Nezrick, Frank A.; Ermelov, P. (National Accelerator Lab., Batavia, Ill.). pp 657-63 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The NAL 15-ft bubble chamber is briefly described; the vacuum vessel, magnet coils, chamber body, and optics system are included. The use of track-sensitive targets in this bubble chamber is discussed, and estimates are given of the filling costs for both chamber and target. It is extremely important to have independent temperature control in the target. It is estimated that, when a neutrino interaction occurs in the target, there will be on the average only 1.5 interactions in the surrounding blanket. Nearly 40% of the chamber volume is visible only by looking through the target; the setting errors and optical distortions in this region will be considerably larger than in the rest of the chamber and this result may somewhat dampen the enthusiasm felt toward the track-sensitive-target technique. (2 figures, 2 tables) (R.W.R.)

20493 RELATIVISTIC INCREASE OF IONIZATION IN BUBBLE CHAMBERS FILLED WITH DIFFERENT GASES. Ermilova, V. K.; Kotenko, L. P.; Merzon, G. I. (Lebedev Inst. of Physics, Moscow). pp 664-6 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

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The density of tracks in a bubble chamber was computed as a function of particle energy by using the Bethe–Bloch formula. Data are plotted for chamber performance when filled with freon ($CBrF_3$), and H_2. (2 figures) (K.S.W.)

20494 TEST OF COUNTER CONTROLLED BUBBLE CHAMBER PHOTOGRAPHY: STUDY OF A COUNTER CONTROL SYSTEM FOR THE SLAC 82" BUBBLE CHAMBER. Brick, D. H. (Massachusetts Inst. of Tech., Cambridge); Goloskie, D.; Pless, I. A.; (and others). pp 667-73 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

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A counter-controlled system which would take pictures only when an interaction occurs is described. It is hoped that pictures with tracks equally spaced in the chamber will be produced and, in addition, digital information indicating which of the tracks contains a usable event. Some typical results are shown; it would take about 40 expansions to get a useful picture in a pion beam. A five-counter array under construction should produce a picture approximately once every two seconds. (3 figures, 1 table) (R.W.R.)

20495 PROPANE–FREON BUBBLE CHAMBER "SKAT." Barabashev, A. Z. (Inst. of High Energy Physics); Gerdyukov, L. N.; Danil'chenko, I. A.; (and others). pp 674-6 of Proceedings of the International Conference on Instrumentation for High Energy Physics. Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

"SKAT" is a 7.5-m^3 bubble chamber filled with a propane–freon mixture and designed with 25 valves for effecting pressure changes and with heat exchange accessories for thermostatic

control of the unit. Other general parameters of the bubble chamber and its magnet are given. (1 figure) (K.S.W.)

20496 STATUS AND NEW TRENDS IN FILM DATA HANDLING. Hough, Paul V. C. (Brookhaven National Lab., Upton, N. Y.). pp 679-701 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

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Areas in which the most useful improvements could be made include economics (people and computing), track-sensitive targets for neutral particles, event rates, and filmless bubble chambers. Recommendations in this area include the following: Forget about filmless bubble chambers, at least for the time being. To improve the productivity of people in data processing, make a general purpose vertex guidance system; make sure that the data are of high reliability (and not merely high precision in favorable cases). Begin to explore computer-assisted scanning, starting with removal of noninteracting beam tracks and continuing with computer indication of tentative vertices. Build a fast digitizer, open-ended in rate, and measure events for any individual group which wants to set up a vertex-guidance scanning shop. Use third-generation computers for reduced costs. Be sure that the system handles film from large chambers incorporating track-sensitive targets. Present-day operating systems are next discussed; and it is concluded that vertex guidance really works, provided that a rugged, efficient fix-up procedure is incorporated to correct and complete the results of computer recognition. The Flying Image Digitizer (FID), under development, can provide a measurement capability of the highest quality, open-ended in rate (at least several thousand events/hr), and at low cost. If vertex guidance (MF) with fix-up proves generally satisfactory, the combination of FID, MG, and third-generation computers can provide nearly an order of magnitude further increase in realized analysis capability at little or no increase in costs. The problems of image contrast and frame-to-frame variation in distortion in the very large chambers with fisheye optics are addressed, and it is concluded that these chambers with track-sensitive targets are likely to keep bubble chambers competitive with other detection techniques for many experiments, including experiments at the highest energies. (8 figures) (R.W.R.)

20497 FAST MINIMUM-GUIDANCE PEPR SYSTEM. Berge, J. P.; Brooks, C. B.; Davey, P. G.; (and others) (Oxford Univ.). pp 702-5 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The performance of the Oxford PEPR system for measuring 740-MeV/c π^- + p and 3.6-GeV/c K^- + p exposures is reported. Hardware and software are discussed: the basic event strategy is derived from the POLLY system. Both the speed and the quality of throughput in the system fell dramatically when operator intervention was necessary; such intervention was a function almost exclusively of the distribution of beam tracks on the film. Measuring events with 4 and 6 prongs as well as 2, ionizing all tracks, and determining end points on dense tracks adds less than 500 ms on the average to the time taken to measure a 2-prong event; confusion due to the increased number of production tracks is small compared with that due to very close beam tracks. (2 tables) (R.W.R.)

20498 CONCENTRIC READER. Kitagaki, T.; Takahashi, K.; Kondo, M.; (and others) (Tohoku Univ., Sendai). pp 706-9 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The "Concentric Reader," for semiautomatic off-line measuring of bubble chamber film at Tohoku University, is described; pattern recognition is made manually and the measurement is done automatically. The accuracy of the measurement of nominally 2.5 μm on film after corrections by software. The machine is suitable for measurement of many-prong events because of pattern recognition by eye and the ease of shifting holes to the next track to be measured. (3 figures) (R.W.R.)

20499 SCANNING AND PRELIMINARY MEASUREMENT SYSTEM FOR BUBBLE CHAMBER PHOTOGRAPHS. Ermolov, P. F.; Zhadkevich, A. L.; Zhil'chenkova, G. D.; (and others) (Inst. of High Energy Physics, Serpukhov, USSR). pp 713-14 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

For measurement and scanning of photographs from a 2-meter propane chamber an accessory arrangement of four tables is provided; the tables hold tape transport mechanisms and electronic circuitry which is on-line to a computer. Projection equipment yields 7× enlargements of the photographs. Various functions of the system are analyzed. (K.S.W.)

20500 REQUIREMENTS FOR ELECTRONIC DETECTION SYSTEM AT THE 200-GeV ACCELERATOR. Roberts, Arthur (National Accelerator Lab., Batavia, Ill.). pp 763-71 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The problems of detecting particles with electronic counters at 50 to 500 GeV are discussed. If kinematic fits are to be used in identifying reactions, the precision of the measurement must be 0.025 to 0.05% for particles about 200 GeV/c. The achievement of such high precision in momentum measurements and high spatial resolution is considered; it has been attained in the laboratory. For sufficiently large and complex systems, vidicon digitalization of wide-gap optical chambers is cheaper than a wire-array digitization system; in addition, it is flexible and easily controlled by computer. The detection and measurement of neutral particles and photons is discussed, and the present state of this rapidly changing field is summarized. (2 figures, 26 references) (R.W.R.)

20501 POSITION MEASUREMENTS OF HIGH-ENERGY NEUTRONS WITH DIGITIZED SPARK CHAMBERS. Schludecker, P. (Univ., Karlsruhe, Ger.); Schmidt-Parzefall, W.; Bott-Bodenhausen, M. pp 772-8 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Preliminary results are reported for position measurements of the interaction points of neutrons in the momentum range from 10 to 21 GeV/c; impact points were measured for 21 GeV/c protons as well, in order to investigate the possibility of testing a neutron detector with protons. Forty measurements were made using different combinations of converter material, converter thickness, incident momentum, and particle type. Two methods of vertex reconstruction were investigated: these used one or four chambers. For one chamber immediately behind the converter, it was found that the best results were obtained by taking, not the coordinate of the center of gravity of the sparks, but the coordinate of the spark that is nearest to the center of gravity. Distributions of the deviations of this value from the incoming proton track show pronounced peaks with quite important tails. For vertex reconstruction with four chambers, every combination of at least three sparks lying on a straight line (±1 mm) was assumed to be the track of a secondary particle. Results for Fe and C converters are tabulated. They show that the requirements for high accuracy and high efficiency are opposed. The results do not show significant differences between neutrons and protons. (3 figures, 1 table) (R.W.R.)

20502 TIME-OF-FLIGHT SPECTROMETER FOR EXPERIMENTS ON THE PROTON SYNCHROTRON IN THE 70-GeV REGION. Vishnevskii, N. K.; Karpov, I. I.; Lapshin, V. G.; (and others) (Inst. of High Energy Physics, Serpukhov, USSR). pp 779-81 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Factors which influence the time-resolution of spectrometers are outlined, with respect to amplitude-compensated shapers used with pulse scintillation counters, the effect of light guides on counter resolution, and the dependence of time resolution on particle beam intensity. The recording of events by a spectrometer is solved through the operation of a preliminary choice system which consists of scintillation counters, activated by coincidence, and Cherenkov threshold counters. In the experimental search for new heavy particles a spectrometer may include circuitry for a comparison of time intervals. This circuitry and its use are briefly discussed. (3 figures) (K.S.W.)

20503 TIME-OF-FLIGHT SPECTROMETER IN THE PICOSECOND REGION. Maksimov, A. N.; Mukhin, S. V.; Ondrish, L.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). pp 782-5 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Time-of-flight measurements were made with a spectrometer equipped with a 1-cm thick crystal which assured maximum light for a minimum amount of matter inserted into the beam. The time resolution of the photomultiplier was inversely proportional to the square root of the light intensity reaching the photocathode. Experiments were made on a π^--meson beam with a momentum of 5 GeV/c. Illumination of a 500 mm scintillator by light pulses from a generator demonstrated a time lag of ±50 ps. (3 figures) (K.S.W.)

20504 SYSTEM APPROACH TO HIGH-SPEED COUNTER LOGIC. Friend, B. (CERN, Geneva); Dufournaud, J. pp 786-8 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A system using fast integrated circuits to trigger spark chambers was developed. The principle of the system is to separate the timing of the counters from the logic performed. The logic is then separated into two parts: generation of hodoscope functions and the combination of these functions defining the required patterns. The equipment for implementing this principle is described. The system, in use for 18 months, is reliable, takes up little space, and is easy to check and verify. (2 figures) (R.W.R.)

20505 AUTOMATIC MEASUREMENT OF THE SCATTERING ANGLE IN TRACK CHAMBERS WITHOUT A MAGNETIC FIELD. Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna USSR). pp 789-91 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Slot and sector holographic filters are compared diagrammatically, with the conclusion that the slotted interrogation of a Fraunhofer diffraction pattern provides information only of the track orientation, and not of the scattering angle. A mathematical model of the pattern of intensity on a Fourier screen suggests that in the general case the high, three-dimensional frequencies are concentrated along straight lines perpendicular to the bisector of the required angle of scattering. (4 figures) (K.S.W.)

20506 CALIBRATION OF A SPARK CALORIMETER BY 20- TO 65-GeV PIONS. Alakoz, A. V.; Vasil'eva, L. F.; Vasil'ev, P. S.; (and others) (Lebedev Inst. of Physics, Moscow). pp 797-9 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A "calorimeter" consisting of eight spark chambers 60 × 60 cm^2 in area was calibrated with pions ranging in energies from 20 to 65 GeV. The spark chambers were interspersed with iron filters. Shower recording in the spark chambers was accomplished photographically. The number of particles was measured as a function of pion energy. A relation was found from the data which indicated the energy resolution of the "calorimeter." (3 figures) (K.S.W.)

20507 DEVELOPMENT OF HIGH ENERGY NEUTRINO DETECTORS. Kaftanov, V. S. (Inst. of Theoretical and Experimental Physics, Moscow). pp 811-25 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The availability of high-energy accelerators and the production of new track detector-spark chambers together furnished the basis for successful neutrino experimentation. This paper is a review of neutrino work beginning with the 1962 Brookhaven experiments and ending with "second generation" experiments which involved the accelerators at Serpukhov and Batavia and produced neutrino beams. (7 references, 6 figures, 2 tables) (K.S.W.)

20508 DEVELOPMENT OF NEUTRINO DETECTORS AT N.A.L. Walker, James K. (National Accelerator Lab.). pp 840-3 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The bubble and spark chambers proposed at NAL for neutrino detection are considered. The bubble chamber, 15 ft long and cycling twice a second, can be operated neon-filled, hydrogen-filled, or with hydrogen-filled track-sensitive target surrounded by neon blanket. At an energy of 30 GeV 500 events a day are expected. The spark chamber, providing roughly two orders of magnitude greater mass than the hydrogen bubble chamber, will provide an initial survey of the gross features of high-energy neutrino interactions. In the detector as described about 1000 events a day are anticipated. (R.W.R.)

20509 SOME REMARKS ON THE TRENDS IN THE RESEARCH ON PARTICLE DETECTORS. Charpak, G. (CERN, Geneva). pp 847-51 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Techniques using multiwire proportional chambers (MWPC) for detection of high-energy particles are discussed. MWPC can be used to determine coordinates of particles or to trigger ordinary spark chambers. Recent progress in the development of MWPC is outlined. (R.W.R.)

20510 TRENDS IN THE DEVELOPMENT OF TRACK PARTICLE DETECTORS. Dolgoshein, B. A. (Moscow Engineering Physics Inst.). pp 852-60 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The requirements to be met in designing new track detectors are listed and discussed: maximum information per unit time, minimum resolution time, minimum dead time, minimum detector stability, and the necessity of determining the identity of secondary particles. The importance of the flatness ΘT (where Θ is inversely proportional to the spatial resolution and T is inversely proportional to the time resolution and deadtime) to detectors is stressed; this characteristic allows evaluation of the merit of new detector types. (2 figures, 1 table) (K.S.W.)

Radiometric Instruments

Refer also to abstract 20405.

20511 MASS RATE DETECTION. Barnard, Johannes Gideon (to K. Baker Associates (Proprietory) Ltd.). Australian Patent 408,211. 27 Nov 1970. Priority date 25 Sep 1967, South Africa.

A method of weighing discrete solid particles such as powders, granules or crushed solids including the steps of causing the particles to fall through a substantially horizontal imaginary window, projecting gamma rays at a substantially uniform rate and flux across the window in a narrow lamella, detecting the gamma radiation traversing the window, and utilizing the change in the amount of radiation detected as the material passes through the window to give a measure of the mass rate at which the material passes through the window is described. (Australia)

20512 METHOD OF MEASURING INTERNAL STRAINS WITHIN ELASTOMERIC MATERIALS USING RADIOACTIVE IMPLANTS. Benzies, J. B. (Dunlop Ltd., Birmingham, Eng.). J. Phys., E (London); 5: 141-4(Feb 1972).

A method is described of measuring the internal strains, caused by externally applied stress within solid elastomeric materials. In principle the method consists of measuring the displacement of radioactive point sources which have previously been embedded into the material. Two methods of observation, one using a pinhole camera and the other a multichannel collimator, are described. An example of the practical use of the method in the measurement of internal strains within small model tyres is presented. (auth) (UK)

20513 PROBE ASSEMBLY FOR LOGGING UNITS FOR TESTING THE MATERIALS FORMING THE WALL OF A BOREHOLE. Meier, Vladimir Alexandrovich (to Osoboe Konstruktorskoe Bjoro). British Patent 1,263,446. 9 Feb 1972. Filed 4 Feb 1970.

The probe assembly described comprises one or more probes provided with a radiation source and a secondary radiation detector, together with an energizing electronic unit. The probes are adapted to be moved along the borehole together with the electronic unit. A movable link is provided that mechanically couples the probe to the electronic unit so as to permit movement of the probe relative to the electronic unit in one plane only, and each probe is provided with spring means for pressing it against the

wall of the borehole. Where the assembly has a number of probes the latter are adapted to be arranged inside the borehole in consecutive fashion, the last probe being connected to the electronic unit by the movable link with similar links between the probes so as to permit movement of all probes relative to the electronic unit in one plane only. An analyzer may be provided outside the borehole to analyze and log the electrical signals from the probes. The analyzer is preferably a radioisotopic x-ray fluorescence instrument or a pulse height analyzer. (UK)

20514 EXPERIMENT ON THE MEASURING EQUIPMENT OF COAL SEAM THICKNESS USING ^{241}Am. Hirota, Toyohiko; Fujimoto, Kaoru; Tsurusaki, Katsuya; Obba, Shigemi (National Research Inst. for Pollution and Resources, Kawaguchi, Japan). Saiko To Hoan; 17: No. 2, 63-70(Feb 1971). (In Japanese).

An equipment which measures the thickness of a coal seam based on the scattering of γ rays is developed with the purpose of controlling the drum head of a shearer loader. It consists of ^{241}Am (10 mCi) as a γ ray source and a NaI(Tl) scintillator of $1\frac{1}{4}'' \times 1''$ as a detector. The distance between the γ ray source and the detector is 19 cm. An experiment on the equipment is made by using some samples of small coal plates and rock plates and a model of coal seam which is 20 m long. The results of that experiment are summarized as follows. 1. The counting rate of scattered γ rays on the coal plates increases according to the thickness of the coal plates until the thickness is about 10 cm, and then the counting rate is saturated. 2. When coal plates adjoin rock plates, this equipment can inform the adjoining face under a deviation of 6 cm. 3. Air space between the equipment and the coal plates has a bad effect on the counting rate of scattered γ rays from coal plates. 4. From the experiment using a model of coal seam, if a suitable time factor and scanning speed are taken, this equipment can measure the thickness of a coal seam continuously at the working spot. (auth) (Japan)

20515 DETERMINATION OF HIGH BORON CONCENTRATION BY MEANS OF THE NEUTRON-RESONANCE METHOD. Vakhtin, B. S.; Filippov, E. M. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 4, 591-2(Apr 1971).

Translated from Zavod. Lab.; 37: No. 4, 461-2(Apr 1971).

A system for determining high boron concentrations is described. The system consists of a neutron source, a foil activation detector (silver or rhodium), a detector system for counting the activated detector, and shielding. (TSS)

Miscellaneous Instruments and Components

Refer also to abstracts 19989, 20243, 20368–20370, 20405, 20867, 21424, 22402–22404, and 22409–22411.

20516 (AERE-R-6713) CAMAC SCHEME: PRESENTATION AT HARWELL ON SEPTEMBER 24, 1970. Bisby, H. (ed.) (Atomic Energy Research Establishment, Harwell (England)). Feb 1971. 40p. Dep. NTIS (U. S. Sales Only). UK 40 pence.

Lectures are presented that outline the main features of CAMAC, give typical CAMAC-compatible modules and controllers, and indicate the advantages and disadvantages of CAMAC as a standardized multiplexing interface for on-line real-time computer applications. An additional part deals with the implications for a CAMAC programming language. (auth)

20517 (JAERI-1217) MEASUREMENTS OF SHORT-LIVED SPECIES UNDER IRRADIATION. A RAPID SCAN SPECTROPHOTOMETER FOR OBTAINING OPTICAL ABSORPTION SPECTRA. Ohno, Shin-ichi; Sakumoto, Akihisa; Takashima, Yohei; Koike, Mitsuru; Motojima, Kenji (Japan Atomic Energy Research Inst., Tokyo). 27 May 1971. 19p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Some problems and recent advances in the techniques of observing short-lived species during γ-ray irradiation are first discussed. On the basis of this discussion, an apparatus is constructed and is combined with a conventional rapid scan spectrophotometer (HITACHI RSP-2 with scanning speed 30 ms/100 nm). By using this system, it becomes possible to measure an optical absorption spectrum in the region of 300 to 700 nm of a liquid sample during a continuous irradiation with ^{60}Co-γ rays at an exposure rate up to 2×10^5 Rh^{-1}. The experiments on aerated aqueous solutions of methylene blue and on other systems show that the method can be used for the investigation of short-lived species having a lifetime of 0.1s or longer. The possibility of studying shorter-lived species with some alteration of the apparatus is also described. (auth)

20518 (RDT-C-7-16-T(1-72)) THERMOCOUPLE ASSEMBLIES, MAGNESIUM-OXIDE INSULATED, STAINLESS STEEL SHEATHED. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 18p. RSO.

A standard is presented for the fabrication of thermocouple assemblies consisting of lengths of stainless steel sheathed, magnesium oxide insulated thermocouple material terminated at the measuring junction end with a measuring junction inside a welded closure, and at the reference junction end with a moisture seal and an optional thermocouple connector. The assemblies are intended for general use in nuclear installations, but are not of sufficient quality to be used in reactor core systems. (W.H.K.)

20519 (RDT-C-11-2-T(1-72)) PYROMETER, HIGH SENSITIVITY, INDICATING AND CONTROLLING. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 6p. RSO.

A standard prescribing requirements for a high sensitivity, indicating and controlling millivoltmeter-pyrometer is presented. (W.H.K.)

20520 (TID-5423) LABORATORY ISOTOPE MASS SPECTROMETER. (Union Carbide Nuclear Co., Oak Ridge, Tenn. K-25 Plant). 16 Sep 1955. 49p. (K-D-631-2). Dep. NTIS. Declassified 9 Oct 1971.

A job specification for a mass spectrometer for determining the percentage of ^{235}U and ^{238}U in UF_6 samples is given. General specifications, general design requirements, performance specifications, and test procedures are presented. (W.H.K.)

20521 (TID-25921) THERMOELECTRIC EVALUATION OF W–Re–Os ALLOYS. (Hoskins Mfg. Co., Detroit, Mich.). 21 Jan 1964. 23p. Dep. NTIS.

For Pratt and Whitney Aircraft, Middletown, Conn.

It was found that the effect of osmium on the thermal emf of alloys of W–5% Re and W–26% Re is of the same sign and approximate magnitude as that of rhenium for relatively large osmium additions (~4% of the rhenium content). For alloys relatively dilute with respect to osmium (~1% of the rhenium content) this was not the observed behavior, particularly with the W–5% Re alloy. The addition of 0.04% osmium to the W–5% Re alloy caused a negative shift in calibration several times larger than the equivalent amount of rhenium. From these results, a substantial calibration shift would be predicted for the W–5% Re alloy after a short irradiation period. The corresponding shift for the W–25% Re alloy would be much less. As a thermocouple, the observed calibration change would be of the magnitude of the shift in the W–5% Re alloy since there is only a small change in the W–25% Re leg. The changes in calibration of these alloys after a long irradiation time are of like sign and magnitude so that they tend to cancel each other. A larger error in temperature indication would be anticipated early in the irradiation cycle than at a later stage. This would include a "peaking" effect in the error curve, but the magnitude and irradiation level for this peak cannot be deduced from these experimental data. (auth)

20522 ION MICROPROBE MASS ANALYZER. Andersen, C. A.; Hinthorne, J. R. (Hasler Research Center, Goleta, Calif.). Science; 175: No. 4024, 853-60(25 Feb 1972).

The instrumentation and analytical methods of an ion microprobe mass analyzer for in situ mass analysis of a microvolume of the surface of a solid sample are described. The hollow-cathode duoplasmatron ion source, electrostatic focusing lens system, and mass spectrometer are described. Various applications of the ion microprobe mass analyzer are discussed and performance data are presented. (26 references) (W.H.K.)

20523 METHOD FOR MANUFACTURING A SEMICONDUCTOR DEVICE AND SUCH DEVICE PREPARED THEREBY. Fujinuma, Koichi (to Tokyo Shibaura Electric Co. Ltd.). British Patent 1,263,009. 9 Feb 1972. Priority date 31 Mar 1969, Japan.

A method is given for forming a semiconductor device which has a high cutoff frequency and a low base resistance. The base region has a narrow width and the portions around the periphery of the emitter region also have a low resistance. The method comprises the steps of preparing a substrate which is a collector region with one type of conductivity, forming a highly doped emitter region with the same type of conductivity, and forming a base contact layer adjacent to the side of the emitter region and with an opposite type of conductivity. The base region is formed by ion implantation through the surface of the substrate, so that it is adjacent to the underside of the emitter region and is connected to the base contact layer. Masking with insulating material with and without impurities is used in the formation of the emitter region and the base contact layer; base impurities are diffused from the doped mask. Embodiments of the method are described in which boron-

ion implantation in Si is used to produce transistors with cutoff frequencies of 8 to 10 GHz and base resistances of 15 to 20 Ω. (D.L.C.)

20524 LARGE SUPERCONDUCTIVE MAGNETS FOR THE APPLICATION IN THE FIELD OF PERTURBED ANGULAR CORRELATIONS. Hollander, R. W. (Univ. of Tech., Delft, Netherlands). pp 607-17 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The design of large superconductive magnets with a high field strength and a large opening angle for use in perturbed angular correlation methods is discussed. (J.W.R.)

20525 ELECTRON-ORBIT ION GAUGE: AN ULTRA-HIGH VACUUM GAUGE. Fitch, R. K.; Rushton, G. J. (Univ. of Aston, Birmingham, Eng.). Vacuum; 21: No. 10, 453-5(Oct 1971).

The electron-orbit ion gauge is a radial field thermionic ionization gauge with a sensitivity greater than 10^5 $torr^{-1}$. It is shown that below a pressure of about 10^{-7} torr it is necessary to operate at an emission of 10^{-7} amp in order to reduce the effects of electron space charge. Measurements were made down to 10^{-10} torr and no low pressure limit was observed. (auth) (UK)

20526 INEXPENSIVE DIGITAL METHOD FOR THE MEASUREMENT OF ISOTOPIC RATIOS. de Sa, A.; Mitchell, J. G. (Univ. of Newcastle upon Tyne, Eng.). J. Phys., E (London); 5: 138-40(Feb 1972).

For isotope analysis the versatility of integrating type digital voltmeters is unnecessary. An inexpensive method of constructing a device which meets all the essential requirements, at a cost which is a fraction of that of commercially available instruments, is described. The device is easily constructed from integrated circuits and has a linearity of response of one part in 10^4. A five digit display and a binary coded decimal (BCD) output are available simultaneously. (auth) (UK)

20527 NEUTRON BEAM INTERFERENCE. Rauch, H. (Oesterreichische Hochschule, Vienna). Acta Phys. Austr.; 33: No. 1, 50-66(1971). (In German).

After a brief treatment of neutron spectrometry and general neutron optics, experiments on the diffraction of neutrons at the slit and grating and the Fresnel biprism interferometer are reported. Since efficient x-ray interferometers were developed in which, for coherent radiation, the interference effect was used on the basis of the dynamic theory of space-lattice interference, an analogous interferometer was proposed for neutrons. The application of this type of spectrometer for the measurement of coherence lengths, refractive indices, and density and magnetization inhomogeneities is discussed. (tr-auth)

20528 CONVERSION OF THE ZEISS Q-24 SPECTROGRAPH TO A RECORDING SPECTROMETER FOR ITS USE IN ISOTOPIC ANALYSIS OF THE NITROGEN. Pascalau, M.; Ungureanu, C.; Constantinescu, Ligia (Inst. of Atomic Physics, Cluj). Stud. Cercet. Fiz.; 22: No. 4, 453-7(1970). (In Rumanian).

A Zeiss Q 24 spectrograph, originally designed for photographic recording, has been converted to an automatic recording spectrometer with a large choice of recording speeds and the possibility to study an extended spectral range. The spectral quality produced by the instrument is adequate for accurate measurements of the relative intensities of emission lines or molecular bands; in particular, bands corresponding to $^{14}N_2$, $^{14}N^{15}N$, and $^{15}N_2$ are sufficiently well resolved for isotopic analysis of nitrogen by this instrument. (auth)

20529 PRECISION COMPUTER MEASUREMENT OF SPECTRA. Steinhaus, David W.; Fisher, Kay J.; Engleman, Rolf Jr. (Los Alamos Scientific Lab., N. Mex.). Chem. Instrum.; 3: No. 2, 141-64(1971). (CONF-701017-7).

From fourteenth annual conference on analytical chemistry in nuclear technology; Gatlinburg, Tenn. (13 Oct 1970).

A digital computer has been programmed to do the complete job of finding and measuring each spectral line in an absorption or emission spectrum. The outputs of position, wavenumber or wavelength, log intensity, and shape of each line are similar to those obtained by a skilled operator using a photoelectric comparator, but are more consistent and are obtained much more rapidly. Many data points on each line are used, and precision measurements can be made on lines covering an intensity range of over 10^3. Many spectra have been processed since the first successful operation in 1962. Continuing improvements to both the apparatus and the computer program are being made. Future plans include a more direct connection to the large digital computer, programmed computer control of the apparatus, computer enhancement of the spectral resolution, and the application to spectrochemical analysis. This system is not limited to optical spectra. Any set of data with peaks or depressions can be processed so as to measure these peaks or depressions. Successful runs have been made on many kinds of spectra. (auth)

20530 COMPUTERIZED ACQUISITION AND PROCESSING OF ISOTOPIC MASS SPECTRA. Christie, W. H.; McKown, H. S. (Oak Ridge National Lab., Tenn.). Chem. Instrum.; 3: No. 2, 99-112(1971). (CONF-701017-5).

From fourteenth annual conference on analytical chemistry in nuclear technology; Gatlinburg, Tenn. (13 Oct 1970).

An IBM 1130 computing system is being used as a data processing unit for a number of mass spectrometers. Interfacing has been developed to allow input to the computer of both digital and analog signals. Provision has been made to accept data on a real-time basis from a mass spectrometer using the cycle-steal technique. Data so accumulated can be stored in the magnetic disk memory until processing is desired. Programs have been written that accumulate the data and process it into a final report. Programs associated with the accumulation of data are written in IBM 1130 Assembly language to facilitate data word manipulation and to allow hardware activation. Processing programs are written in IBM 1130 FORTRAN IV language. These programs provide for the calibration of the mass spectrometer and reduction of the raw data to a meaningful form. (auth)

20531 FORTRAN PROGRAMS TO DESIGN MASS SPECTROMETERS WITH COMPLETE SECOND-ORDER FOCUSING. Smith, David H.; Christie, W. H. (Oak Ridge National Lab., Tenn.). Chem. Instrum.; 3: No. 2, 165-74(1971).

Two FORTRAN computer programs have been written that design mass spectrometers with complete second-order focusing for any magnetic analyzer of fixed radius. These programs make the coefficients B_1, B_2, and B_{22} of the focusing equation exactly zero by simultaneously solving the proper expressions to satisfy this condition. In the first program, SARCH, regions are sought where the remaining two second-order coefficients, B_{11} and B_{12}, change sign. The second program, DFCAL, analyzes these regions of interest in detail. It attempts to make B_{11} and B_{12} smaller than a suitable preset value using a successive approximation technique. When successful, the values of all the physical parameters required to meet these conditions are printed out in tabular form. Tables describing what input information is required and how it is punched on cards are included. Sample outputs from each program are shown and explained. The overall program logic is presented in the form of a flow chart. Listings of the programs are available from the authors upon request. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

20532 (KFK-1550) REPORT ON RESEARCH AND DEVELOPMENT WORK IN THE YEAR 1970. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). 235p. (In German). Dep. NTIS (U. S. Sales Only).

Reported are activities conducted in the scientific institutes and departments of the society for nuclear research at Karlsruhe during 1970. Included is work on the projects "fast breeder" and "fissionable material control." Aside from nuclear problems, studies are directed toward data evaluation, development of new techniques, and environmental burden through technical processes. With respect to the nuclear area, increased emphasis is placed on isotope separation, production and application of actinides, and on nuclear safety. (H.B.G.)

20533 (TID-4067) ISOTOPES DEVELOPMENT PROGRAMS RESEARCH AND DEVELOPMENT: 1971. Progress Reports on Sponsored Work. (Division of Applied Technology (AEC), Washington, D. C.). Feb 1972. 157p. Dep. NTIS.

The USAEC sponsors isotopes research and development work at the national laboratories and at various academic and industrial facilities. The major technical program areas include: development of improved methods for producing radioisotopes; use of radioisotopes as heat sources for generating power; development of radioisotope techniques to aid in solving environmental problems and to explore the oceans; development of safe radiation sources for process radiation; development of low-dose radiation processing method for preserving foods; and the evaluation of methods for expediting wide-scale use of the technology developed by the isotopes program. A short summary is presented of the objectives, results accomplished in 1971, and future plans for each research or development project within each of these program areas. Indexes for author, corporate author, and subject are provided. (L.C.L.)

Isotope Separation (Industrial)

20534 (MLM-1886) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: OCTOBER-DECEMBER 1971. (Mound Lab., Miamisburg, Ohio). 10 Feb 1972. Contract AT(33-1)-Gen-53. 24p. Dep. NTIS.

Research progress is reported on: carbon isotope separation by CO distillation, chemical exchange, thermal diffusion, conversions, and Freon-11 distillation; separation of stable isotopes of Ar, He, Kr, Ne, and Xe; thermal diffusion research; and low-temperature research. (M.C.G.)

20535 (ORO-684) AEC GASEOUS DIFFUSION PLANT OPERATIONS. (Atomic Energy Commission, Washington, D. C.). Jan 1972. 53p. Dep. NTIS.

Information is presented on the physical features, operating requirements, economics, potential improvements, and capabilities of each of the three gaseous diffusion plants. The comparative economics of joint versus independent plant operations are discussed. Facility improvement data and new plant cost estimates are presented. (M.C.G.)

20536 PROCESS FOR SEPARATING URANIUM ISOTOPES. Fenn, John B.; White, James R. (to Mobil Oil Corp.). U. S. Patent 3,626,665. 14 Dec 1971. Filed 29 Aug 1969.

Uranium isotopes can be separated utilizing shock separation techniques by introducing gaseous uranium hexafluoride, alone or in admixture with inert gaseous diluents, at supersonic velocity into a duct such that parallel flow streamlines are present, and by placing within the supersonic parallel flow stream a plurality of hollow probes having critical dimensions relative to the mean free path of the flow stream in front of the probes so as to cause a detached stationary shock to form ahead of each probe leading edge. The flow through the probes in relation to the flow through the duct is such that the maximum amount of separative work is accomplished. This maximization of separative work does not occur either at the highest enrichment of the heavier isotope in the sampling probes or at the highest feasible withdrawal rate of gas through said probes but only at a narrow range of critical parameters. (Official Gazette)

20537 CONTRIBUTION TO THE ELEMENTARY INTEGRATION OF NONLINEAR TRANSPORT EQUATIONS IN ISOTOPE SEPARATION. PART III. Zieger, K. (Zentralinstitut fuer Isotopen- und Strahlentechnik, Leipzig). Isotopenpraxis; 7: No. 9, 373-9(Sep 1971). (In German).

Elementary integration of a special boundary and initial value problem to the simplest version of Cohen's system of partial differential equations was carried out. In the first instance this mathematical formulism serves for the time-dependent description of the separation of a binary isotope mixture in a half-open countercurrent column with constant cross section. (auth)

20538 SEPARATION OF SULFUR ISOTOPES THROUGH CHEMICAL EXCHANGE. Egiazarov, A. S.; Kavalidze, M. Sh.; Kerner, M. N.; (and others). Isotopenpraxis; 7: No. 9, 379-83 (Sep 1971). (In Russian).

Comparison of the different sulfur isotope separation methods with regard to the production of considerable quantities of highly concentrated sulfur isotopes shows that the method providing chemical exchange in the system sulfurous anhydride-bisulfite ion is the most promising. However, the results obtained by several authors are divergent as to the value of the elementary separation factor and further parameters, and insufficient for a technological process. The elementary separation factor α was determined through single-action equilibration of sulfur isotopes at 25, 50, and 70°C, as well as in a column of known efficiency for the isotopes $^{32}S/^{33}S$ and $^{32}S/^{36}S$ at a temperature of 70°C. (auth)

20539 ENRICHED URANIUM. Maertensson, M. M. (Aktiebolaget Atomenergi, Stockholm). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 85, 11-33(Sep-Oct 1970). (In French). (CONF-700903-21).

From fourth Foratom Congress on industrial aspects of the nuclear fuel cycle in Europe; Stockholm, Sweden, (21 Sep 1970).

The contributions of several European countries (France, England, Italy, and Germany) to improvements in uranium enrichment methods are reviewed. Three enrichment processes are studied: gaseous diffusion, centrifugation, and by nozzles. The industrial situation in the different countries using the processes is analyzed. A comparison of the different processes is made and the supply and demand of enriched uranium studied. (auth) (France)

20540 FRENCH PROGRAM IN THE FIELD OF U ISOTOPE ENRICHMENT. Pecqueur, Michel (OCEA, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.; No. 90, 5-9(1971). (In French). (CONF-710344-1).

From fourth annual conference of the Japan Atomic Industrial Forum; Tokyo, Japan (15 Mar 1971).

Studies on the development and industrialization of enrichment techniques are being undertaken in France. The French atomic energy commission (CEA) intends to create a large gas diffusion plant in 1973. The preparation of this project takes into account: the requirements of the market, and the disequilibrium in the production facilities of the western sector; the application of the various possible processes; the economic improvements associated with separation by gaseous diffusion. France is also undertaking studies in the field of ultracentrifugation from the long term point of view. (France)

20541 SEPARATION OF LIQUID MIXTURES BY THERMODIFFUSION IN AN ELECTRIC FIELD. Kuchinov, V. P.; Nikolaev, V. I.; Tubin, A. A. At. Energ. (USSR); 32: No. 2, 167-9(Feb 1972). (In Russian).

The thermal diffusion method of separation offers possibilities for isotope enrichment. In order to test the influence of an electric field on the process, pairs of organic liquids (heptane-benzene or hexane-cyclohexane) were placed in a 150 mm column equipped for a temperature differential and a constant electrical field. The temperature differential between the thermodiffusion wall was 8°C, with a median temperature of 10°C. The presence of the field increased the separation effect, and it is suggested that parasitic currents were suppressed. (K.S.W.)

20542 INDUSTRIAL PRODUCTION OF HEAVY WATER. Kortus, Josef; Zoch, Oldrich (Czech Atomic Energy Commission, Pargue). Jad. Energ.; 17: No. 9, 291-6(Sep 1971). (In Czech).

Present methods for producing heavy water are critically examined and the difficulties in constructing new plants are discussed. The possibilities of manufacturing heavy water in the Czech SSR are discussed, with especial regard to the economics of isotope exchange methods using H_2S and NH_3. Technological and economic problems and developmental difficulties to be encountered in the initial study of such a project are reviewed. (tr-auth)

Isotopic Power Sources

Refer also to abstracts 20198-20200, 20202-20207, and 20218.

20543 (GEMS-402) SNAP-27: SUMMARY REPORT. (General Electric Co., Philadelphia, Pa. Space Div.). 15 Jul 1970. Contract AT(29-2)-2581. 574p. Dep. NTIS.

Declassified 18 Oct 1971.

The SNAP-27 Radioisotope Thermoelectric Generator (RTG) System was designed, developed, and fabricated as the prime power supply for the Apollo Lunar Surface Experiment Package (ALSEP). The program began in late 1965, and the first electrically heated units were delivered in late 1966. Initial power requirements of 56 watts were exceeded; each of the five flight units will produce more than 67 watts after one year of lunar operation. The last flight hardware was delivered in May of 1969. Safety approval was granted in June of 1969 for the Apollo 12 and subsequent flights. The SNAP-27 program was extremely successful in that NASA was provided with a power system exhibiting exceptional performance and reliability. (auth)

20544 (TID-5572) DYNAMIC CHARACTERISTICS AND EQUATIONS FOR A CONTROL SYSTEM ANALYSIS OF A MERCURY POWER CONVERSION SYSTEM. Mueller, Milton W.; Ross, Daniel P.; Leovic, William J. (Thompson Products, Inc., Cleveland, Ohio). 27 May 1957. 88p. (ER-3234). Dep. NTIS.

A study was made of a control system for regulating a mercury vapor power conversion unit capable of supplying 500 W(e) to a battery load for 60 d with maintenance-free, reliable operation. Information is included on the system requirements, characteristics, and dynamic equations pertinent to such a study. (L.C.L.)

20545 APPLICATION OF SHORT-LIVED ISOTOPES TO HEAT WORKING BODIES. Balyberdin, V. V. Samoletostr. Tekh. Vozdush. Flota; No. 18, 35-7(1970). (In Russian).

A proposal on the use of the short-lived isotopes of Al to heat the working body in jets is examined. Existing concepts of the activation of specimens in jet irradiators are considered and a relationship is obtained for specimen activity as a function of neutron flux, cross-section of irradiated core for thermal neutrons, and several other variables. The irradiation time is assumed to be five times the half-life. For thermal neutron fluxes in the center of a motor, with a value of 10^{15} neutrons/cm^2, the mass of the irradiated specimen must be 3.64×10^6 kg. The energy released in radioactive beta-decay will be adequate only for a 100-s flight of a rocket with a lift-off weight of 30 tons. (JPRS)

20546 RADIOISOTOPE FUEL. Garber, Harold J. (to United States Atomic Energy Commission). U. S. Patent 3,632,520. 4 Jan 1972. Filed 4 Jan 1968.

A radioisotope fuel source is described whose gamma-ray emission is so low as to be harmless having a reasonably constant power output over a long interval of about 50 years. The source includes at least a pair of isotopes such as ^{238}Pu and ^{241}Pu. One isotope, ^{238}Pu, has a decreasing thermal power output after the start of delivery of power and the other, ^{241}Pu, has a low thermal power output at the start of delivery of power and an increasing thermal power output after the start of delivery of power; the increase in the second (^{241}Pu) compensating for the decrease of the first (^{238}Pu). (Official Gazette)

20547 RADIOISOTOPIC POWER SOURCE. Cottam, Alfred E.; Chi, John W. H.; Kim, Chang-kyo; Flaherty, Robert (to United States Atomic Energy Commission). U. S. Patent 3,638,023. 25 Jan 1972. Filed 7 Nov 1969.

A power source adapted for refueling during operation including a core structure having longitudinal openings for holding radioisotopic fuel elements and longitudinal passageways for passing process fluid flow is described. Each fuel element opening is sealing separated from the process fluid flow passageways. The process fluid flow passageways are arranged in an even number of annular patterns or passes such that the process fluid inlet and outlet conduits are located at one end of the core. The fuel element openings are accessible at the opposite end of the core to allow fuel replacement without loss of process fluid. A fuel element shipping and transfer cask is adapted to be attached to the heat source opposite the coolant ports for replacing spent fuel elements within the core structure. A passive, self regulating, and recoverable emergency cooling system prevents core melt down on loss of coolant flow. (Official Gazette)

20548 CONTROLLED VENT FOR ISOTOPE FUEL CAPSULE. Cottam, Alfred E. (to Westinghouse Electric Corp.). U. S. Patent 3,633,033. 4 Jan 1972. Filed 19 May 1969.

A controlled vent for an isotope fuel capsule utilizes physical passages for gas flow which are large enough to permit either viscous or free molecular flow to take place and are small enough or sufficiently tortuous to prevent passage of fuel particles. A plurality of punctured thin metal discs or foils are stacked together with the holes misaligned to form a continuous flow channel, thereby permitting gas generated within the capsule to escape through the vent. Thus, the weight and volume of the fuel capsule can be reduced since the internal pressure is reduced. (Official Gazette)

Radiation Sources

Refer also to abstracts 20172, 20259, 20295, and 20373.

20549 STATUS AND PROSPECTS OF USING ISOTOPES IN MINING AND METALLURGY. Holzhey, Joachim. Neue Huette; 16: No. 12, 705-10(Dec 1971). (In German).

The most significant general advantages of isotope and radiation technology in industry and the effects on the economy are outlined. The status of worldwide isotope use is discussed, with a presentation of data on nuclear testing equipment in the Soviet Union such as numbers of thickness gages and defectoscopes in use. Tracer methods employed include the movements of surface and subterranean waters, settling effects, and steel melting processes. The status of German isotope use in mining and metallurgy is resolved into 17 different applications to devices and processes and their increase over the years 1958 through 1970. Prospects for the continued growth of the use of isotopic devices and measuring instruments are discussed. (K.S.W.)

20550 RADIOISOTOPE SOURCES FOR X-RAY RADIOMETRIC ANALYSIS OF THE ELEMENTS FROM SODIUM TO CALCIUM. Vander, I. Z.; Gerling, I. Z.; Ioffe, E. M. Geofiz. App.; No. 42, 171-3(1970). (In Russian).

In x-ray radiometric analysis of the light elements with atomic numbers less than 20, ^{238}Pu, ^{3}H : Zr, ^{3}H : Ti, and ^{55}Fe have been used as sources. The detection of x-radiation has been accomplished in vacuo by a flow-through proportional counter with argon-methane filling. Investigations show that ^{238}Pu, ^{3}He : Zr, and ^{3}He : Ti sources are advisable for analyzing the elements from Na to P, and ^{55}Fe and ^{3}H : Ti sources for the elements from S to Ca. (Geophys. Abstr.)

20551 FUNDAMENTALS OF RADIOISOTOPE APPLICATIONS. Muth, H. (Univ. des Saarlandes, Homburg, Ger.). Monatsschr. Kinderheilk.; 118: No. 6, 184-8(1970). (In German).

Decisive for the amount of the radiation risk in nuclear medicine are the following factors: effective radiator dose; temporal dose distribution; spatial dose distribution; and critical organ. The development of new detectors with high response probability, of new very sensitive measuring methods and arrangements, and the production of very short-lived radionuclides may open up interesting possibilities of application of nuclear medicine in pediatrics without the danger of damaging radiation effects on the organisms of children. (INIS)

Design and Fabrication

Refer also to abstract 20219.

20552 PRODUCTION OF MONOENERGETIC X-RAY SOURCES OF KNOWN ABSOLUTE INTENSITY. Ebert, P. J.; Gaines, J. L.; Leipelt, G. R. (Univ. of California, Livermore). Nucl. Instrum. Methods; 99: No. 1, 29-34(1972).

Sources of monoenergetic photons were produced by using the bremsstrahlung from a radiographic x-ray machine. Fluorescent x rays (5 to 98 keV) emanating from metal foils (>99% pure) in the bremsstrahlung beam were filtered to absorb K_β and L x rays as well as bremsstrahlung scattered by the foil. In this way strong sources ($\approx 10^{11}$ photons/s) with <10% spectral contamination were obtained. Absolute photon fluxes were determined by counting photons through a known-area pinhole 3 m away from the source. (auth)

20553 ELECTRODEPOSITION OF PROTACTINIUM. Prakash, S.; Singh, R. J.; Ramaniah, M. V. (Bhabha Atomic Research Center, Trombay, India). Inorg. Nucl. Chem. Lett.; 8: No. 2, 113-17(Feb 1972).

Methods adopted for the preparation of thin uniform Pa sources are briefly reviewed. In this connection it is stated that no study of electrodeposition from non-aqueous media appears hitherto to have been made. In the method described a stock solution of Pa in HCl/HF was evaporated to small volume and pipetted into isopropyl alcohol to give a solution that contained the desired ^{231}Pa concentration (~10 to 20 g/ml). The electroplating cell consisted of a stainless steel cup and a perspex cylinder, with a Au coated Al sheet cathode and a Pt wire anode. The current was maintained at 1mA using a voltage of 400 to 600 V. The amount electrodeposited varied from 1 to 60 g/cm^2 and the deposition was very uniform. (UK)

20554 METHOD OF PREPARING A ^{252}Cf NEUTRON. Boulogne, Alexander R.; Faraci, Jean P. (to United States Atomic Energy Commission). U. S. Patent 3,627,691. 14 Dec 1971. Filed 8 Jan 1970.

A method of encapsulating a radioisotope is described wherein an open ended tube is used first to support a porous member for filtering a radioisotope precipitate from a solution and next for containing the precipitate on the porous member while heating to convert the radioisotope to a thermally stable form. The tube is then sealed at both ends providing a leak-tight capsule to prevent loss of the radioisotope. This method is particularly applicable to the encapsulation of ^{252}Cf for use as a point source of neutrons. (Official Gazette)

Industrial Uses

Refer also to abstracts 20013, 20250, 20563, 20588, 21731, 21733, and 21734.

20555 (JAERI-M-4395) PRESENT STATUS ON FOOD IRRADIATION IN EUROPE. Sato, Tomotaro (Japan Atomic Energy Research Inst., Tokyo). Apr 1971. 93p. (In Japanese). NTIS (U. S. Sales Only).

Details of the Board of Management meeting for the International Project on Food Irradiation held in Paris in Nov. and Dec. 1970 are discussed, and recent developments in food irradiation methods in Europe are described. (auth)

20556 (ORNL-IIC-3) IODINE-125. Baker, P. S.; Gerrard, Martha (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 34p. Dep. NTIS.

The preparation, fabrication into sources, and uses of ^{125}I are reviewed. Reactor irradiation of ^{124}Xe is said to be the most practical method of production. Recovery and analysis procedures, source fabrication, industrial applications, environmental applications, and medical applications are discussed. (171 references) (M.C.G.)

LIFE SCIENCES

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 20097, 20114–20116, 20127, 22059, and 22060.

20557 FREE RADICAL DISTRIBUTION IN GAMMA-IRRADIATED DNA. Gregoli, Silvano; Bertinchamps, Albert (Univ. Libre, Brussels). Int. J. Radiat. Biol.; 21: No. 1, 65-73(Jan 1972).

Previous ESR investigations performed on purine·pyrimidine nucleotide complexes, γ-irradiated at 25°C, showed the occurrence of complete spin transfers from the purine to the pyrimidine nucleotides. The dTMP·dCMP complex was studied under the same conditions and with the following results: among the various dTMP radicals, only the H-addition radicals could be transferred to the dCMP. This result was in agreement with the mechanism suggested previously, according to which, for a transfer to occur the donor molecule must go through an anionic phase during its radical evolution, for while the TH radicals arise from the evolution of T^- anions, the other dTMP radicals do not. As a result, they cannot be involved in the transfer and remain localized on dTMP. The validity of this mechanism was confirmed by the fact that, in the dGMP · dAMP · dTMP · dCMP complex, the two types of transfer took place simultaneously: complete transfers from purine to pyrimidine nucleotides and incomplete transfer from dTMP to dCMP. These results were applied to the interpretation of the spin migration within the DNA, γ-irradiated at 25°C. In this molecule, as in the four nucleotide complex, all the radiation damage was localized on the pyrimidine nucleotides. No purine signal was detectable. The modifications of the DNA spectra as a function of several experimental factors were studied, and were ascribed to changes in the relative intensities of the pyrimidine patterns in the spectrum. (auth)

20558 GENETIC CONCEPTS AND NEOPLASIA. Twenty-Third Annual Symposium on Fundamental Cancer Research, Houston, Texas, March 5–7, 1969. Baltimore; Williams and Wilkins Company (1970). 630p. $17.00. (CONF-690302).

Separate abstracts were prepared for five papers presented at the conference. An additional 22 papers were presented on various aspects of genetics in relation to neoplasia. (H.L.W.)

For abstracts of individual papers see: 20559–20561, 20564, and 20592.

20559 STUDIES ON THE ENZYMATIC JOINING OF DNA STRANDS. Gellert, Martin; Little, John W.; Oshinsky, Carol K.; Zimmerman, Steven B. (National Institutes of Health, Bethesda, Md.). pp 548-54 of Genetic Concepts and Neoplasia. Baltimore; Williams and Wilkins Co. (1970).

From twenty-third annual symposium on fundamental cancer research; Houston, Tex. (5 Mar 1969). See CONF-690302.

A review is presented of enzymes (polynucleotide ligase or DNA ligase) capable of carrying out the final rejoining step of the DNA repair process. They have been purified from Escherichia coli infected with bacteriophage T4, from uninfected E. coli, and from mammalian tissues. Mechanisms of the DNA joining reaction are discussed and it is pointed out that breaks produced by irradiation are not repairable by DNA ligase alone but require the full process of excision, resynthesis, and rejoining. Physical and chemical properties of DNA ligase are discussed and the use of ligase-defective mutants of E. coli in studies on cellular function of DNA ligase is considered. DNA ligase activity was assayed in uv-sensitive, x-ray-sensitive and recombination deficient strains of E. coli in an attempt to discover suitable mutants. (H.L.W.)

Radiation Effects on Cultured Cells (External Source)

20560 REPAIR REPLICATION OF DAMAGED DNA IN VIVO. Hanawalt, Philip C. (Sanford Univ., Palo Alto, Calif.). pp 528–47 of Genetic Concepts and Neoplasia. Baltimore; Williams and Wilkins Co. (1970).

From twenty-third annual symposium on fundamental cancer research; Houston, Tex. (5 Mar 1969). See CONF-690302.

A review is presented of repair replication of damaged DNA in mycoplasmas and other bacteria as well as in more complex cells such as the protozoans and mammalian cells. A postulated sequence of enzymic steps in the excision-repair scheme is shown by means of a diagram. The method for experimental detection of repair replication is discussed and a diagram is presented to show the basic protocol for the demonstration of normal replication and repair replication of DNA in growing cells. A review is given of repair replication in various systems, including Escherichia coli, Mycoplasma laidlawii, Tetrahymena pyriformis, HeLa cells, and cultured skin fibroblasts. Various deleterious agents, such as ultraviolet and x radiation, nitrogen mustard, and nitrosoguanidine, that stimulate repair replication in bacterial systems are briefly discussed. The relationships of normal nucleic acid metabolism to repair replication are reviewed. (H.L.W.)

20561 NONCONSERVATIVE REPLICATION OF DAMAGED DNA IN MAMMALIAN CELLS. Painter, R. B. (Univ. of California, San Francisco). pp 593-603 of Genetic Concepts and Neoplasia. Baltimore; Williams and Wilkins Co. (1970).

From twenty-third annual symposium on fundamental cancer research; Houston, Tex. (5 Mar 1969). See CONF-690302.

Cultures of HeLa cells were grown in media containing FUdR and ^{3}HBUdR and exposed to 300 kvp x radiation at a rate of 1200 R per min. The cells were then washed and suspended in saline-sodium citrate. The preparation was centrifuged and fractions were collected. Cells were analyzed from various fractions and the results, shown by means of graphs, indicate that synthesis of DNA occurred in the third gradient. Difficulties of showing repair replication after exposure to ionizing radiation are demonstrated by this experiment. Comparisons are made with effects of ultraviolet radiation and the nature of nonconservative synthesis is discussed. (H.L.W.)

Radiation Effects on Microorganisms (External Source)

Refer also to abstracts 20560 and 20574.

20562 METHYLATION OF DNA IN ULTRAVIOLET-IRRADIATED BACTERIA. Ryan, Ann M.; Borek, Ernest (Columbia Univ., New York). Biochim. Biophys. Acta; 240: 203-14(30 Jun 1971).

Methylation of DNA continues in Escherichia coli K12, W, and B strains in which net synthesis of the polymer has been eliminated by ultraviolet irradiation. This appears to be independent of dimer excision, yet degradation of DNA in the post-irradiation period does modify the ultimate level of overmethylation. DNA methylated in vivo after irradiation has a decreased ratio of 6 methyl adenine to 5-methylcytosine relative to that found when the labeling occurs during logarithmic growth. In addition, a decrease in the activities of the DNA methylases in crude extracts is evident 8 to 12 min after irradiation; heterologous DNA reisolated from such reaction mixtures exhibits a drop in both 6-methyladenine and 5-methylcytosine label with distortion of the 6-methyladenine/5-methylcytosine ratio. Since the methylating capacity falls, the overmethylation observed in irradiated bacteria may not be attributable to new enzyme specificities. We suggest that a relaxation of the restrictions on DNA methylation which usually prevail occurs as a result of ultraviolet irradiation damage. (auth)

20563 EFFECTS OF IONIZING RADIATION ON MICROORGANISMS AND RADIATION STERILIZATION (SURVEY). Tumanyan, M. A.; Pershina, Z. G. (Inst. of Epidemiology and Microbiology, Moscow). Zh. Microbiol., Epidemiol. Immunobiol.; No. 5, 75-80(May 1971). (In Russian).

The radiosensitivity of microorganisms is compared with that of animals and plants: a classification of microorganisms is presented according to their increasing resistance to x-rays, gamma-, and beta-rays (bacteria, molds, yeasts, spores, viruses, and phages); mutations are described; and the causes of the unequal susceptibility of cells in one culture are discussed. With decreasing size of individual cells, increasing concentration of cells per ml of suspension, poor nutrition, abundant oxygen supply, and temperature above 40°C, the sensitivity of the microorganisms to ionizing irradiation increases. As for the stage of growth, sensitivity is greatest at the beginning of cell division. Due to its bactericidal effect, ionizing radiation is used for sterilization of food products and other objects whenever thermal and chemical methods are unsuitable (packaged products, for instance). The main problems to be resolved in the area of radiation sterilization are:

selection of the most suitable source of rays; determination of effective doses; investigation of the sterility and harmlessness of irradiated products; and development of better sterilization methods and equipment for standard and special production conditions. (JPRS)

20564 REPAIR OF DNA IN HAEMOPHILUS INFLUENZAE. III. EXCISION AND RECOMBINATION DEFECTS AND THE SITE OF REPAIR OF ULTRAVIOLET-IRRADIATED TRANSFORMING DNA. Setlow, Jane K.; Boling, M. E.; Beattie, K. L. (Oak Ridge National Lab., Tenn.). pp 555-69 of Genetic Concepts and Neoplasia. Baltimore; Williams and Wilkins Co. (1970).

From twenty-third annual symposium on fundamental cancer research; Houston, Tex. (5 Mar 1969). See CONF-690302.

A review is presented of studies on repair of ultraviolet-irradiated transforming DNA in Haemophilus influenzae. Experiments were conducted to determine whether repair of uv-damaged transforming DNA could take place before or after integration of the DNA into the recipient cell genome. Results led to the conclusion that almost all of the repair of transforming DNA takes place after integration. Studies on the effects of repair of uv damage on transcription and experiments on defective excision of pyrimidine dimers in uv-sensitive mutants are reviewed. Studies on defective recombination in an ultraviolet-sensitive mutant resulted in the conclusions that H. influenzae phage makes use of the recombination mechanism belonging to the host cell and that the uv-sensitive mutant does have a defective recombination mechanism. (H.L.W.)

Radiation Effects on Plants (External Source)

20565 (AED-CONF-71-100-46) STIMULATING ACTION OF LOW DOSES OF IONIZING RADIATION IN PLANTS. Glubrecht, H.; Niemann, E.-G. (Gesellschaft fuer Strahlenforschung m.b.H., Munich (West Germany). Institut fuer Strahlenbotanik, Technische Universitaet, Hanover (West Germany)). May 1971. 14p. (CONF-710901-533). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Field and greenhouse experiments were conducted on strawberries, carnations, barley and rye. Three varieties of strawberries, Senga sengana, S. praecosa, and Lihama sp., were exposed to gamma radiation at doses of 100 to 400 rad; a 20% increase in yield was found. Rooted and unrooted cuttings of carnations were given 10 to 10,000 R doses of x radiation. Doses of 80 to 300 R resulted in increased numbers and length of roots. An increased yield of barley was found following exposure to 50 and 100 R doses of x radiation. Maximum stimulation of straw yield was obtained from winter rye exposed to x radiation during the early stage of stalk development. Laboratory experiments were conducted on algae, duckweed, and pine pollen. Following exposure of the algae, Ankistrodesmus braunii and Chlorella pyrenoidosa, to low doses of x radiation, cell size and spore numbers were increased. Effects of light and temperature on x-radioinduced growth stimulation in the duckweed, Lemna minor, were investigated. A stimulation of pine pollen germination was found following ultraviolet irradiation. (H.L.W.)

20566 (CONF-700909-, pp 277-86) EXPOSURE-RATE EFFECTS ON SOYBEAN PLANT RESPONSES TO GAMMA IRRADIATION. Constantin, M. J.; Killion, D. D.; Siemer, E. G. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Seedlings of Glycine max (L.) Merrill were γ irradiated at either 2 to 3 or 12 days postemergence and scored for seedling growth reduction at either 25 to 30 days postemergence or for stem length at various times through maturity and yield. The results showed an exposure-rate effect the extent of which was dependent on exposure, stage of development when irradiated, and/or the end point scored. Seedling responses showed a rate saturation at 50 R/min, whereas the mature-plant responses showed a rate saturation at 25 R/min. Shoot dry weight was decreased to 50% of control by 3 kR at 50 R/min and by 5 kR at 10 R/min. Yield was reduced to approximately 50% of control by 2.5 kR at from 6.25 to 50 R/min. At 5.0 kR, yield was approximately 20% of control at 6.25 R/min, 10% at 12.5 R/min, and essentially zero at 25 and 50 R/min. Results of a split-exposure experiment demonstrated repair, which occurred within a radiation-free period of 30 to 120 min at an exposure of 4 kR. Decreasing the exposure rate from 36.4 to 20 R/min permitted a greater degree of repair to occur in the plants than occurred during a split exposure of 4 kR at 50 R/min with a radiation-free period of 120 min. (auth)

20567 (CONF-700909-, pp 287-305) EFFECTS OF ACUTE GAMMA IRRADIATION ON DEVELOPMENT AND YIELD OF PARENT PLANTS AND PERFORMANCE OF THEIR OFFSPRING. Siemer, E. G.; Constantin, M. J.; Killion, D. D. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

The effects of acute γ irradiation on the development and yield of soybean, rice, and corn plants were determined. Plants were grown in containers outdoors and exposed once during their life cycle to ^{60}Co γ radiation at 50 R/min. Performance of their offspring was determined under greenhouse conditions. Yield of soybean plants receiving 2.5 kR was either unaffected or reduced to approximately 50% of control depending on their stage of development when irradiated. At early bloom 1 kR reduced yield significantly and 3 kR eliminated it. Two weeks later, during late bloom, 2 kR reduced yield significantly and 6 kR eliminated it. Branch abscission was a factor in the reduction of seed yield in soybeans. Yield of rice plants exposed to 25 kR was either reduced or eliminated depending on the stage of development when the plants were irradiated. The plants were most sensitive to radiation during the time from panicle initiation to anthesis. When plants were irradiated in small peat pots 2 days after emergence (DAE) with minimal radiation attenuation to the shoot meristem, 5 kR reduced yield significantly and 15 kR eliminated it. An exposure of 2.5 kR essentially eliminated yield of a corn plant irradiated during the period from tassel initiation through silking. An exposure of 500 R reduced yield significantly when 1-DAE plants were irradiated in small peat pots. Periods of relative tolerance to γ irradiation were observed during early vegetative phase when sucker proliferation occurred and just prior to pollination and fertilization. It appears that, if the parent plant produces seed when it is irradiated prior to fertilization and embryogenesis, emergence and seedling growth of the offspring will be normal. If the parent plant produces seed when it is irradiated after fertilization, however, emergence and seedling growth of the offspring will reflect the decrease in sensitivity of the developing embryo. (auth)

20568 (CONF-700909-, pp 306-24) EFFECTS OF EXPOSURE TIME AND RATE ON THE SURVIVAL AND YIELD OF LETTUCE, BARLEY, AND WHEAT. Bottino, P. J.; Sparrow, A. H. (Brookhaven National Lab., Upton, N. Y.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Experiments were conducted to compare the effects of ^{137}Cs γ radiation given as either 1-, 4-, 8-, or 16-hr treatments at constant rates (CR) with 36-hr fallout-decay-simulation (FDS) or with buildup (Bu) and fallout-decay-simulation (Bu + FDS) treatments with variable exposure rates. Seedlings of lettuce were given Bu + FDS, FDS, and 1-, 4-, 8-, and 16-hr Cr treatments. Barley and wheat seedlings were given FDS and 8- and 16-hr CR treatments. Following irradiation the lettuce plants were transplanted to the field, barley to the greenhouse, and wheat to a growth chamber. The criteria of effect used were survival and yield. Young barley seedlings were given a total exposure of 1600 R at 32 different rates ranging from 60 to 4800 R/hr. The first leaf of each seedling was measured after 8 days of growth. For equal total exposures, FDS treatments were more effective than 16-hr CR treatments in reducing survival and yield of all three crops. The ratio of 16-hr CR to FDS at LD_{50} was 1.43 for lettuce, 1.23 for barley, and 1.37 for wheat. For yield the FDS was more effective only at exposures above the LD_{50}. Lettuce survival increased with exposure time between 1 and 16 hr, but this was a linear increase only after 4 hr. Barley seedling height decreased as the exposure rate increased from 60 to about 1000 R/hr. Further increases in exposure rate above 1000 R/hr had no further effect on seedling height. The greater effectiveness of the high exposure rates observed in these experiments substantiates our conclusion that the increased effect of an FDS treatment compared with a 16-hr CR treatment is attributable to the high initial exposure rates of FDS. Similar results for survival and yield reduction for the 8-hr CR and the FDS treatments were observed. Hence investigators lacking the facilities to simulate fallout decay could use an 8-hr CR treatment to approximate the effects of simulated-fallout-decay treatments. (auth)

20569 (CONF-700909-, pp 325-42) DOSE-FRACTIONATION STUDIES AND RADIATION-INDUCED PROTECTION PHENOMENA IN AFRICAN VIOLET. Broertjes, C. (Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen (Netherlands)). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Leaves of African violet, which develop adventitious buds on

petioles after rooting, have been used as test material for dose-fractionation studies with x rays and fast neutrons. The parameters used were survival of the leaves, production of adventitious plantlets per leaf, and mutation frequency. The aim of the experiments was to determine the relation between initial dose, time interval, and the extent of the radioinduced protection. The "optimal" initial dose inducing maximal protection (equivalent to approximately 3 krads) proved to be 500 rads of x rays and fast neutrons at an "optimal" time interval of 8 to 12 hr. Repeated irradiations with the optimal initial dose at 8-hr time intervals induce a protection much higher than that of a single pretreatment, reaching a maximum after approximately 10 irradiations. No qualitative differences were found between x rays and fast neutrons. The relative biological effectiveness (RBE) for protection is found to be 1, whereas the RBE for acute irradiations is 2. The results presented are discussed and compared with literature data dealing mainly with mammals. A few questions arise about the significance of the phenomena described in relation to radiotherapeutic procedures. (auth)

20570 (CONF-700909–, pp 343-51) SUMMARY OF RESEARCH ON FALLOUT EFFECTS ON CROP PLANTS IN THE FEDERAL REPUBLIC OF GERMANY. Glubrecht, Hellmut (Technische Universitaet, Hanover (West Germany). Gesellschaft fuer Strahlenforschung M.b.H., Munich (West Germany). Institut fuer Strahlenbotanik). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Two groups of experiments are discussed. The first was concerned with effects of stratospheric fallout with relatively low activities (10^{-9} to 10^{-4} Ci/m^2/day). Various species of plants were exposed to continuing artificial ^{89}Sr, ^{90}Sr, or ^{137}Cs fallout in special growth chambers. Uptake of the radionuclides by aboveground parts of the plants and by roots could be controlled, and the distribution in various plant organs was checked. Damaging effects could be observed only at activities of at least 10^{-5} Ci/m^2/day. At lower fallout activities, however, some parameters (dry mass, plant height, etc.) were significantly increased as compared with the control. In the second group of experiments, the effects of external γ irradiation were investigated in field experiments with barley, wheat, rye, and potatoes. Irradiation was performed at various stages of development and, on some cereals, also during hibernation. Parallel experiments on chronic exposure of the same crop species were carried out in a small γ field. The results were in good agreement with data obtained by investigators in other countries. The radiation sensitivities of about 20 of the most common varieties of barley and wheat grown in West Germany were compared. Maximal differences of dose values resulting in the same degree of damage were ±30%. (auth)

20571 (CONF-700909–, pp 352-69) RADIATION DOSES TO VEGETATION FROM CLOSE-IN FALLOUT AT PROJECT SCHOONER. Rhoads, W. A. (EG and G, Inc., Goleta, Calif.); Ragsdale, H. L.; Platt, R. B. (Emory Univ., Atlanta, Ga.); Romney, E. M. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Project Schooner was a nuclear cratering experiment in the Plowshare Program for peaceful application of nuclear explosives. On the basis of information from two earlier experiments, Palanquin and Cabriolet, special dosimeters for measuring both β and γ radiation were placed in the open environment and on shrubs in the downwind area where fallout was anticipated. In addition, polyethylene sheets were placed over some shrubs to determine whether the shrubs could thus be protected against radiation damage. The γ radiation doses for shrubs not covered were found to be essentially the same as the doses measured in the open and away from shrubs, but there was a 15% reduction in dose under the sheets. The β doses to unsheltered vegetation were, however, reduced by almost 50% compared with doses at 25 cm in the open. This reduction was attributed to self-shielding. Beta doses to the shrubs were reduced still further, to 31% of the 25-cm β dose in the open, by shielding the shrubs from direct fallout contamination. The estimated LD_{50} for Artemisia was 4449 rads, but the reduction in dose by the shelters was nearly sufficient to prevent damage to the shrubs, even though all other Artemisia shrubs in the center of the fallout pattern were killed. It was concluded that β doses must be considered in protecting growing food crops and livestock and that even minimal shelter to prevent direct surface contamination would be of great importance. (auth)

20572 (CONF-700909–, pp 370-95) SURVIVAL AND YIELD OF CROP PLANTS FOLLOWING BETA IRRADIATION. Schulz, Robert K. (California Univ., Berkeley. Dept. of Soils and Plant Nutrition). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Field experiments were carried out to investigate the effect of β radiation on the growth of wheat, lettuce, and corn. The β-radiation was accomplished by fusing ^{90}Y onto 88- to 175-μ silica sand, and applying the sand to the crops with a remote-control applicator. Treatment levels on the wheat and lettuce crops ranged up to 59.4 mCi of ^{90}Y per square foot. In the corn experiment the highest level was 71.3 mCi of ^{90}Y per square foot. Wheat grain production was severely reduced when 6.6 mCi/sq ft of ^{90}Y was applied. This corresponds to approximately 2700 rads at the surface of the plant near the apical meristem. Lettuce yields were reduced significantly only at the highest treatment level, 59.4 mCi/sq ft, which corresponds to 9300 rads at the plant surface near the apical meristem. Some abnormalities could be seen on the lettuce at the 6.6 mCi/sq ft treatment level. Corn yield was not reduced and plant appearance was not changed in any of the treatments. The apical meristem of the corn plant was protected by about 1 cm of tissue, and it hence received very little ionizing radiation. (auth)

20573 (CONF-700909–, pp 454-81) ECOLOGICAL EFFECTS OF ACUTE BETA IRRADIATION FROM SIMULATED-FALLOUT PARTICLES ON A NATURAL PLANT COMMUNITY. Murphy, Peter G.; McCormick, J. Frank (North Carolina Univ., Chapel Hill. Dept. of Botany). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Simulated-fallout particles overcoated with ^{90}Y were applied at two levels of activity to granite-outcrop communities. The experiment resembled conditions expected at a site 170 miles downwind of a 2.5-Mt detonation with a wind velocity of 15 mph. Mean community dose levels were 7000 and 4000 rads. In the 7000-rad communities, the ratio of mean ground-surface dose (8770 rads) to mean canopy dose (5092 rads) was 1.7. In the 4000-rad communities, the mean ground-surface dose (4824 rads) was 1.6 times higher than the mean canopy dose (2996 rads). In the 7000-rad communities, the death of 46% of all terminal buds in the dominant Viguiera porteri resulted in a 37% height-growth reduction, a compensatory lateral branch development, a 16% reduction in community biomass, and a lower, more clumped, vertical distribution of leaves in the canopy. Comparison with earlier studies indicated that acute β irradiation may be twice as effective as chronic γ irradiation at equivalent total doses in causing height-growth reduction in V. porteri. No radiation-induced change in the metabolism of the outcrop ecosystem was detected through measurements of CO_2 exchange 43 days after fallout dispersal. The mean rate of net production on clear days in both July and September (9:30 a.m. to 4:40 p.m.) was 1.2 gC/m^2/hr. Early nighttime rates of respiration (9:30 to 10:10 p.m.) averaged 2.9 gC/m^2/hr in July and 2.2 gC/m^2/hr in September. (auth)

20574 (CONF-700909–, pp 482-91) EFFECT OF NUCLEAR WAR ON THE STRUCTURE AND FUNCTION OF NATURAL COMMUNITIES: AN APPRAISAL BASED ON EXPERIMENTS WITH GAMMA RADIATION. Woodwell, G. M.; Holt, B. R. (Brookhaven National Lab., Upton, N. Y.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

The combined effects of blast, fallout, fire, and other disturbances that might be associated with a nuclear war would involve a complex pattern of changes in natural communities which are best described as "loss of structure." The changes include a shift in the composition of the communities away from highly integrated arrays of species characteristic of evolutionarily and successionally mature communities toward the generalists of the loosely integrated communities of disturbed areas. This series of changes is accompanied by a reduction in net production and frequently by a reduction in the potential of the site to support living systems. The changes, which are associated with a wide range of disturbances, are especially significant in the case of nuclear war because effects might occur over such large areas as to delay the normal processes of recovery. (auth)

20575 (CONF-700909–, pp 595-607) SENSITIVITY ANALYSIS OF AGRICULTURAL DAMAGE ASSESSMENT. Brown, Stephen L. (Stanford Research Inst., Menlo Park, Calif.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

This paper discusses the sensitivity of conclusions drawn from damage-assessment studies of fallout effects on agriculture to variations in the assumptions, parameter values, and models used. Among the parameters analyzed for sensitivity were the assumed data of nuclear attack; the type, weight, and efficiency of the attack with respect to agriculture; the season over which feed and food crops were assumed to be vulnerable; the lethal and threshold dose criteria; the dose-rate multiplier; and the β-to-γ dose ratio (which

is, in turn, influenced by foliar retention, time of arrival, and the soil-roughness attenuation factor). The sensitivities are compared both qualitatively and quantitatively. (auth)

20576 (CONF-700909–, pp 608-15) APPLICATION OF DAMAGE-ASSESSMENT DATA IN U. S. AGRICULTURAL DEFENSE PLANNING. Easton, Bruce M. (Department of Agriculture, Washington, D. C.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

In making plans and developing programs to carry them out in the event of a nuclear war, the principle of simulating postattack conditions is followed as nearly as possible. The best simulated-damage-assessment data available are applied to every planning step. Most damage-assessment data used in agricultural defense planning are prepared by computer at the National Resources Analysis Center of the Office of Emergency Preparedness (OEP). The USDA works with OEP on food and agriculture resources in this computer. Input data in the computer model on damage to crops and livestock come from members of this symposium. (auth)

20577 (CONF-700909–, pp 616-25) UNITED KINGDOM CONSIDERATIONS IN AGRICULTURAL DEFENSE PLANNING. Neal, W. T. (Ministry of Agriculture, Fisheries and Food, London (England)). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

The food-supply situation in the United Kingdom for two to three years postattack is examined. In the absence of imports and assuming a surviving population of 40 million (i.e., about 75% survival), a severe food shortage would exist. Attention is drawn to the severe limitation on accurate assessment owing to a lack of knowledge about the β-radiation contribution to the total radiation damage to crops and livestock from fallout. (auth)

20578 (ORNL-4759) ECOLOGICAL SCIENCES DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1971. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 188p. Dep. NTIS.

Progress is reported on the following research projects: radionuclide cycling in terrestrial ecosystems; terrestrial and aquatic system interaction; the ecology of an eastern deciduous forest biome; systems ecology and environmental systems analysis; radiation effects in terrestrial ecosystems; effects of radiation on aquatic systems; radionuclide cycling in aquatic systems; thermal effects studies; the functions of the ecological sciences information center; applications modeling; and applications research. A list of 422 recent publications is included. (H.L.W.)

20579 (SGAE-LA-6/1971) EFFECTS OF γ-RAYS ON GROWTH, YIELD, AND N CONTENT OF ADUR AND SVENNO SUMMER WHEAT. Zvara, J.; Haunold, E. (Oesterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf. Institut fuer Landwirtschaft). [1969]. 29p. (In German). Dep. NTIS (U. S. Sales Only).

In laboratory and greenhouse experiments the influence of γ-irradiation (0, 100, 500, 1000, 5000 and 10,000 rad), fertilization (basic dressing, basic + top dressing) and spring-wheat variety (Adur, Svenno) on growth, yield, and nitrogen content of the kernels was studied. Seed irradiation caused a growth retardation as shown by emergence, development of the seedlings, number and fresh weight of shoots per pot. At harvest time growth retardation was not noticeable any more. Kernel yield decreased in 1969 from 1000 and in 1970 from 5000 rad and straw yield from 10,000 rad on. The nitrogen content of the kernels increased with dose, the variations from season to season were, however, greater than the stimulation effect caused by the irradiation. Adur was higher in yield than Svenno. Top dressing caused yield increases in all cases. (auth)

20580 EXPERIMENTAL MUTATIONS OBSERVED IN HAPLOID TOBACCO PLANTS OBTAINED BY IN VITRO CULTURE OF IRRADIATED ANTHERS. Devreux, M.; Saccardo, F. (CNEN, Rome). Atti Ass. Genet. Ital.; 16: 69-71(1971). (In Italian). (RT/BIO-(71)18).

Flower buds of Nicotiana tabacum were given 1000 R of x radiation. Following irradiation, five anthers of each bud were placed in a culture medium recommended for obtaining haploid plants. At the time of treatment the anthers contained microspores near the reduction stage of meiosis. Large quantities of haploid seedlings were obtained; some of the seedlings were transplanted in soil and analyzed for phenotypes. The aberrant phenotypes, manifested as variations in plant height, leaf shape, and color, were presumed to be caused by radioinduced mutations. Cytological analysis of 50 plants revealed chromosomal aberrations in three of them. Polyploid nuclei were found in stem discs cultured in vitro. (H.L.W.)

20581 CYTOGENETICS OF INDUCED ASYNAPSIS IN BARLEY. Sethi, G. S.; Gill, K. S.; Ghai, B. S. (Punjab Agricultural Univ., Ludhiana, India). Indian J. Genet. Plant Breed.; 30: No. 3, 604-7(Nov 1970).

Asynapsis was induced in the barley variety C. 164 by treating the seeds with 40 kR ^{60}Co gamma rays. There was no conjugation of the homologous chromosomes at pachytene and all the subsequent meiotic stages were highly irregular. The asynaptic plants produced highly sterile pollen and there was no seed setting. The asynapsis was controlled by a single gene that was recessive to that for normal meiosis. (auth)

20582 USE OF X- AND GAMMA RAYS IN CREATING WINTER FORMS OF PISUM SATIVUM L. AND P. ARVENSE L. Sachanski, S. Genet. Selek.; 3: No. 1, 29-41(1970). (In Bulgarian).

Podobren Plovdivski, Hödinger, and Baltersbacher strains of peas are most radioresistant, followed by Ramonski 77, Uladovski 303, Dokuchaevski and Raman. X- and gamma rays used as mutagenic agents by pre-sowing irradiation of P. sativum and P. arvense seed lead to the development of plants with valuable economic properties which may be used as breeding material for developing new winter pea varieties. (auth) (INIS)

20583 EFFECTS OF GAMMA RADIATION ON TULIP BULBS. Haunold, E. (Reaktorzentrum, Seibersdorf, Austria). Bodenkultur; 22: No. 4, 387-92(Nov 1971). (In German).

The present paper describes radiation experiments with tulips. The bulbs were irradiated with ^{60}Co γ-rays usually in October, just before planting. At doses above 500 rads growth of the plants was retarded by an average of 65%; also flowering was delayed. The varieties differed greatly in radiation sensitivity. Doses of 250 and 500 rad caused color changes of the varieties Golden Age and Jewel of Spring, showing up as red dots and streaks on otherwise yellow petals. These color changes were not inheritable. (auth)

20584 INHERITANCE OF POD ARRANGEMENT AND SEED COLOUR IN BRASSICA JUNCEA. Nayar, G. G.; George, K. P. (Bhabha Atomic Research Centre, Bombay). Indian J. Genet. Plant Breed.; 30: No. 3, 579-80(Nov 1970).

Appressed pod mutants and yellow seeded mutants were obtained from the Rai 5 variety of mustard by treatment with beta and x irradiation. Reciprocal crosses were made between Rai 5 and the mutants. Tables are presented to show segregation for pod arrangement and seed color in the F_2 population. Appressed pod arrangement and yellow seed color were recessive to open pod arrangement and blackish brown seed color of the parental strain Rai 5. (H.L.W.)

20585 RADIATION INDUCED VARIATION IN RICE IMPROVEMENT. Saini, S. S.; Sharma, D. (Punjab Agricultural Univ., Ludhiana, India). Indian J. Genet. Plant Breed.; 30: No. 3, 569-78(Nov 1970).

Dry seeds of two rice varieties viz., Jhona-349 of Punjab and Taichung (Native)-1 of Taiwan, and F_2 of crosses between them were treated with 20, 30, 40 and 50 kr of gamma rays from a ^{60}Co source. To study the variability in R_2 generation, space plant rows from 40 randomly selected R_1 panicles of each treatment and the respective controls, were grown in a split plot design with three replications. Data were recorded for earing date, plant height, tillers and yield per plant on five randomly selected plants in each row. The mean value of a character in 38 out of 48 treated populations remained unchanged in spite of increase in the variance while in the remaining 10 cases it recorded significant and unidirectional shift from that of the control. The genetic variance in the hybrid material was greater in magnitude than that obtained in the pure types for all the characters; and except for tillers per plant it further increased after irradiation, showing a supplementary effect to the variance normally released by hybridization. The heritability estimates and genetic gains also followed the same trends. The maximum expected genetic gain was 74.17% for yield in the hybrid material treated with 20 kr. The range of individual plant values expanded after irradiation with one or more doses and for maximum increase different dose was required for different characters in different genotypes. Thirty mutants with extreme values, not available in the original populations, were isolated and some of them had good combination of useful characters and plant type for growing under condition of high fertility. The frequency of such variants was higher in the treated than in the untreated hybrid material and the treated pure types. It was concluded that for effecting improvement in various economic characters of rice plant, hybridization followed by irradiation may be better than hybridization alone. (auth)

20586 INFLUENCE OF RADIATION AND CHEMICALLY INDUCED STERILITY ON MUTATION FREQUENCY AND SPEC-

TRUM IN BARLEY. Sharma, R. P.; Bansal, H. C. (Indian Agricultural Research Inst., New Delhi). Indian J. Genet. Plant Breed.; 30: No. 3, 544-50(Nov 1970).

Seeds of barley (var. N.P. 104) were treated with gamma-rays (40 kR) and chemical mutagens (EMS 0.3% and NMU 0.01%) with a view to studying the relationship between M_1 seed sterility and chlorophyll mutation frequency in M_2 generation. The results obtained suggest that the capacity of an agent to induce mutations may not have a similar bearing on plant fertility. Further, the spikes having different degrees of fertility give different mutation frequencies and spectrum. The relationship between these parameters, however, has been shown to be dependent upon the type of mutagen used. (auth)

20587 M_1 CHLOROPHYLL CHIMERAS INDUCED BY DIFFERENT MUTAGENS AND THEIR M_2 CHLOROPHYLL MUTATION YIELDS IN RICE. Karunekaran, K.; Kiss, I. S. (Ontozesi es Riztermesztesi Kutato Intezet, Szarvas, Hungary). Biol. Plant. (Prague); 13: No. 3, 207-8(1971).

Studies with gamma rays, fast neutrons, and various EMS treatment of rice showed a higher frequency of M_1 chlorophyll chimeras after EMS treatment, a correlation between the frequency of M_1 chlorophyll chimeras and that of M_2 chlorophyll mutants, and a higher M_2 mutation frequency in the progeny of chimerical M_1 plants compared with those of normal-looking plants. (auth) (INIS)

20588 EFFECT OF GAMMA RADIATION ON THE PECTIN OF STRAWBERRIES AT DIFFERENT MATURITY STAGES. Belli-Donini, M. L.; Taggi, R. (CNEN, Casaccia, Italy. CNEN, Rome). Ind. Conserve; 45: No. 1, 23-8(1970). (In Italian).

Red Gauntlet strawberries were picked at different maturity stages and given 200 krad of γ radiation by means of a ^{60}Co source. After irradiation the strawberries were held at a temperature of 0 to 3°C and a relative humidity of 90 to 95%. The effects of irradiation on pectic substances and pectin-methylesterase activity as well as the changes in oxygen uptake were studied. According to the stage of ripeness at which the strawberries were irradiated different responses to the irradiation were found with regard to pectin metabolism and oxygen uptake. (INIS)

20589 MUTAGENIC SENSITIVITY IN SORGHUM. Sree Ramulu, K. (Agricultural Coll. and Research Inst., Coimbatore, India). Madras Agr. J.; 58: No. 1, 33-5(Jan 1971).

Mutagenic sensitivity of various species of Sorghum to x radiation and pyrocatechol and pyrogallol has been investigated, using the seeds of two varieties of CO 11 (S. durra) and CO 12 (S. subglabrecens) of sub-series durra and male sterille C. K. 60 A (S. caffrorum) I. S. 84 (a derivative of Feterita group) and their hybrid C. S. H. 1 of subsection Arundinacea and two chromosomal forms namely 2n = 20 and 40 of S. halepense of subsection Halepensea of Eu-Sorghum. The percentage germination and survival showed a decrease with increase in the dose of x-rays in all varieties. The species belonging to sub-series caffra were more sensitive than durra. The varieties CO 11 and CO 12 of durra did not show different sensitivity to x-rays. However, the variety CO 11 was more resistant than CO 12 to treatments with pyrocatechol and pyrogallol. Variation in sensitivity was noticed not only between different crop plants of unrelated families but also between different genera, species, sub-species and varieties. The comparative study on sensitivity between the hybrid and parents revealed that the hybrid C. S. H. 1 was the most sensitive and I. S. 84 the most resistant. Of the two chromosomal forms, S. halepense with 2n = 40 was found to be more resistant than S. halepense with 2n = 20. The species belonging to sub-series durra and caffra of sub-section Arundinacea were found to be more resistant to radiations than the species of the sub-section Halepensea. (INIS)

20590 STUDY OF THE RADIOSENSITIVITY OF SOYBEANS BY IRRADIATION OF SEED WITH GAMMA-RAYS. Georgiev, G.; Topchieva, A. Genet. Selek.; 3: No. 5, 403-9(1970). (In Bulgarian).

Results obtained from a study of the effect of ^{60}Co gamma-rays on three soya-bean varieties and on intervariety hybrid (F_1) in M_1: Adams, Iregi, Pavlikeni 2 and Adams x Iregi are discussed. The soybean varieties studied possess a different resistance to the ^{60}Co gamma-rays. The varieties are arranged according to their resistance at 16 kR, as follows: Iregi–79.20; Adams x Iregi–59.35; Adams–57.72 and Pavlikeni 2–34.60%. The critical dose in the case of Adams and Adams x Iregi is slightly above 16 kR, and in that of Pavlikeni 2, is slightly above 12 kR. The critical dose in the case of Iregi is above the highest dose of irradiation (16 kR) used. With the increase in the dose of irradiation the frequency of damaged nuclei of the meristem root cells in the first mitotic division also rises. There exists almost full correlation between them ($r = 0.96 \pm 0.14$). Irradiation has a strong effect on the reproductive organs of the soya beans. With the increase in the dose of irradiation, the number of fully sterile plants also rises, and the number and weight of the seeds on an average per plant drops. The doses of 4 and 8 kR had a stimulative effect on the number and weight of seeds in the case of the Adams variety. (auth) (INIS)

Radiation Effects on Animals (External Source)

Refer also to abstracts 20348 and 21776.

Man

Refer also to abstract 20292.

20591 (CONF-700909–, pp 31-50) BETA-RADIATION DOSES FROM FALLOUT PARTICLES DEPOSITED ON THE SKIN. Mikhail, S. Z. (Environmental Science Associates, Burlingame, Calif.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Absorbed β-radiation dose expected from fallout particles deposited on the skin was estimated by use of the Beta Transmission, Degradation, and Dissipation (TDD) model. Comparison of computed doses with the most recent experimental data relative to skin response to β-energy deposition leads to the conclusion that, even for fallout arrival times as early as 10^3 sec (16.7 min postdetonation), no skin ulceration is expected from single particles 500 μ or less in diameter. Doses from arrays of fallout particles of different size distributions were computed also for several fallout-mass deposition densities; time intervals required to accumulate doses sufficient to initiate skin lesions were calculated. (auth)

20592 IONIZING RADIATION AND TUMOR PRODUCTION. Lewis, E. B. (California Inst. of Tech., Pasadena). pp 57-77 of Genetic Concepts and Neoplasia. Baltimore; Williams and Wilkins Co. (1970).

From twenty-third annual symposium on fundamental cancer research; Houston, Tex. (5 Mar 1969). See CONF-690302.

A review is presented of factors affecting the radiation dose–response relationships for the induction of leukemia and other types of neoplasms in man. The probability of a tumor per unit dose of radiation per year seems closely dependent on age, so far as can be estimated from a review of studies of radiation-induced carcinogenesis in man. The average value of this probability for leukemia is on the order of one or two cases of this disease per million persons per rad to the marrow per year during childhood and early adult life in white populations (or, apparently, during all ages in Japanese populations). The value, however, is estimated to be 10 to 20 cases per million per rad per year during fetal stages in white populations. It may be inferred from Doll's analysis (1962) that this value may be reached again, or exceeded, at least in white males, over 60 years of age. These estimated values of the probability of leukemia are apparently applicable for only eight to 10 years if irradiation is given during the fetal stage, but may apply for 10 to 20 years if irradiation is given at any time after birth. New data are presented which define the pattern of mortality from LHS (lymphatic and hematopoietic system) neoplasms in groups of medical specialists and other physicians. Three groups of specialists, radiologists, dermatologists, and urologists, have a remarkably aberrant pattern of such neoplasms; i.e. a disproportionately large number of leukemia deaths (and possibly multiple myeloma deaths, as well) occur in relation to deaths from lymphomas. In the case of radiologists and dermatologists, at least, it is likely that this aberrant pattern is the result of occupational exposure to radiation. (auth)

20593 EXPOSURE OF AUXILIARY PERSONNEL TO RADIATION IN VETERINARY RADIOLOGY. Nechvatal, M. (Univ., Brno). Vet. Med. (Prague); 16: No. 10, 649-58(Oct 1971). (In Czech).

The surface doses ascertained by means of dosimetry in the course of the currently applied x-ray examinations of the different body regions of domestic animals are reported. The doses applied to the skin surface of animals at the place of the impact of the central ray and the surface doses applied to the auxiliary personnel fixing the animal in the course of examination are considered. Of the doses applied on the skin surface of animals at the place of the impingement of the central ray in the case of an exposure of the helper to a primary bundle of rays, the required quantity of pictures is stated for the reaching of the tolerance dose applied to the whole body, to the hands and forearms, and to the legs and ankles. Of the surface doses measured in the helper, the author

states the quantity of pictures required for the reaching of the tolerance dose applied to the whole body, to the hands and forearms, and to the legs and ankles. From the time of the highest frequency of x-ray examinations carried out in 1963 and 1969 at the x-ray department of the University of Veterinary Medicine in Brno, the data are given of the actual exposure of helpers, and this exposure is compared with the annual tolerance doses. (auth)

20594 HEAVY LYSOZYMURIA AFTER X-IRRADIATION OF THE SPLEEN IN HUMAN CHRONIC MYELOCYTIC LEUKAEMIA. Tischendorf, F. W.; Ledderose, G.; Mueller, D.; Wilmanns, W. (Univ., Tuebingen, Ger.). Nature (London); 235: No. 5336, 274-5(4 Feb 1972).

Large quantities of a basic protein were found, by electrophoretic analysis, in the urine of five out of seven cases of chronic myelocytic leukemia after x-irradiation directed against the enlarged spleen. In one case the protein was found before x-ray therapy, but irradiation caused an increased protein response. The protein was characterized as a relatively low molecular weight constituent with the enzymatic properties of lysozyme. The x-ray therapy consisted of doses of 4 to 5 × 100 R. Details of the changes in blood and urine in a typical case are shown graphically. In the light of previous studies heavy lysozymuria in patients with chronic myelocytic leukemia mirrors the increased lysosomal breakdown induced by x-irradiation of the granulocytic cells and their precursors. It was found that secondary lysozymuria following splenic irradiation is not related to the presence or absence of the Philadelphia chromosome in the granulocytic precursors. Amongest conclusions reached is that chronic myelocytic leukemia may serve as a source of genetically modified enzyme proteins important in analyzing the relationship between amino-acid sequence and enzymatic activity. (UK)

20595 RADIOBIOLOGIC DETERMINATION OF THE TOTAL DOSE IN RADIOTHERAPY. Holsti, L.; Rissanen, P. M.; Spring, E. (Univ. of Helsinki). Acta Radiol., Ther., Phys., Biol.; 10: No. 3, 289-97(Jun 1971).

Autopsy findings in carcinoma of the lung of patients treated with megavoltage radiotherapy were analyzed according to their calculated cell survival fraction values. The results indicate two boundary lines for cell survival values; the calculated value should be below the first line to give any probability at all, and below the second line to produce a high probability of no malignant tissue remaining in the region treated. (auth) (Sweden)

20596 DETERMINATION OF THE CORRELATION BETWEEN BLOOD CELL MORPHOLOGY AND THE ABSORBED RADIATION DOSES IN PERSONNEL EXPOSED TO IONIZING RADIATION. Lobodziec, Wlodzimierz; Pinkwart, Harry; Czaplewski, Stanislaw (Inst. of Oncology, Gliwice, Poland). Pol. Przegl. Radiol. Med. Nukl.; 35: No. 5, 629-31(Sep-Oct 1971). (In Polish).

The total individual doses of gamma radiation received by medical personnel were compared with their blood cell counts. No correlation was observed between the blood cell count and morphology and the doses received by the personnel. (auth)

20597 COMPLICATIONS FOLLOWING USE OF ^{198}Au IMPLANTS FOR PITUITARY ABLATION IN TREATMENT OF ADVANCED CARCINOMAS. Piotrowski, W.; Penzholz, H. (Univ., Heidelberg). Neurochirurgia; 14: 150-6(Jul 1971). (In German).

The anatomical variations in the sellar region which can lead to complications in pituitary ablation for advanced carcinoma were noted during a clinic analysis of 50 patients who, on the strong suspicion of a pituitary tumor, were treated with implants of ^{198}Au. Among the results, of which some have survived 14 years, one always finds a few unusual cases of meningitis, hemorrhage in the region of the sella, and damage due directly to radiation or to its being misdirected. The causes of these complications are reported, as well as the time when they were recognized and the treatment, which among other measures involved several urgent craniotomies. The possible complications are compared with the advantages of a pituitary ablation with radioactive gold, which in certain cases competes with surgery. (auth)

Vertebrates

Refer also to abstracts 20574–20578, and 20645.

20598 (CONF-700909–, pp 224-33) RESPONSES OF LARGE ANIMALS TO RADIATION INJURY. Jones, David C. L. (Stanford Research Inst., Menlo Park, Calif.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Recent data pertaining to the relations between dose rate and lethality in sheep exposed to dose rates ranging from high (hundreds of roentgens per hour) to low (less than 1 R/hr) are incorporated in a review of the field. It is concluded that even within the high dose-rate range there is a significant inverse relation between $LD_{50/60}$ and dose rate and that discernible radiation injury does accrue even at dose rates less than 1 R/hr. The chronology of lethality and hematologic changes in sheep during continuous exposure to death at dose rates of 3.74 and 1.96 R/hr are compared with those observed during terminated exposure at 0.84 R/hr. At 1.96 R/hr there is no indication of reduction in survival time by overirradiation, whereas at 3.97 R/hr there is a marked compression in the range of survival times. Chronology and extent of changes in circulating leukocyte counts vary appreciably with dose rate during protracted exposure. (auth)

20599 (CONF-700909–, pp 234-44) CRITERIA FOR RADIATION INJURY. Krebs, John S. (Stanford Research Inst., Menlo Park, Calif.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

The nature of radiation injury in animals is considered largely from the viewpoint of destruction of radiation-sensitive cells and tissues. The methods for determining the 37% survival dose (D_{37}) in animals are reviewed; the limitations of treating cell survival after irradiation as an exponential process are considered briefly; and some of the principal results on survival of animal cells are summarized. The relation of bone-marrow-cell survival to survival or death of the whole animal is considered. In two experimental comparisons the LD_{50} of the animal was predictable from the survival of the bone-marrow cells; in two other experimental comparisons there was no relation between stem-cell survival and LD_{50}. The rate of replacement of the bone-marrow cells after irradiation is considered briefly. Data collected from three independent sources gave a mean cell doubling time of 1.33 days (range, 0.96 to 1.7) for replacement of bone-marrow cells of rats and mice. There was no significant delay in initiation of recovery and no evident relation between cell doubling time and radiation dose. (auth)

20600 (CONF-700909–, pp 245-58) SPECIES RECOVERY FROM RADIATION INJURY. Spalding, J. F.; Holland, L. M. (Los Alamos Scientific Lab., N. Mex.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

The acute dose of γ radiation required to produce death of livestock may range from as little as 300 to as much as 800 rads. All mammalian species have a recovery capability or an increased tolerance, or both, to protracted radiation which is not necessarily related to the acute lethal dose for the species. Recovery from single acute or protracted nonlethal exposures may be expected within 90 to 120 days in most mammalian species, leaving no irreparable somatic lesion of consequence to livestock. Transient or permanent sterility may be caused in some mammalian species by nonlethal doses of radiation. However, hereditary radiation-induced genetic injury following nonlethal exposures to ionizing radiation should not be of serious concern to livestock breeders. (auth)

20601 (CONF-700909–, pp 269-76) PROBLEMS IN POST-ATTACK LIVESTOCK SALVAGE. Griffin, S. A.; Eisele, G. R. (Oak Ridge National Lab., Tenn. UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Studies were initiated in 1968 to determine whether the meat from irradiated animals could be utilized safely by humans in a nuclear disaster. Pigs weighing approximately 200 to 250 lb were exposed to 700 R (air dose) of whole-body γ irradiation at 1 R/min. Blood samples were taken before and after irradiation to detect bacteremia. No evidence of bacteremia was found in any of the pigs. Various bacteria were isolated from the lymph and liver. In some animals bacteria were isolated from the muscles. No difference in the incidence of bacterial invasion was found between irradiated and control animals. Not being able to detect bacteremia in pigs, we conducted a pilot study on rats to verify previous work and to evaluate our techniques. Rats exposed to 800, 900, and 1000 R of whole-body γ irradiation at 50 R/min developed bacteremia, the severity and incidence increasing with the increase in total dose. (auth)

20602 (CONF-700909–, pp 419-33) PREDICTION OF SPECIES RADIOSENSITIVITY. Cromroy, Harvey L.; Levy, Richard; Broce, Alberto B.; Goldman, Leonard J. (Florida Univ., Gainesville). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

A study was made on the feasibility of using the mammalian co-

lumnar epithelial cell of the duodenum and the insect endothelial cell of the midgut as biological indicators of radiation sensitivity. Thirty species of mammals and twenty species of insects were used. Data demonstrating situations where the respective cells would be most useful as parameters for radiosensitivity are presented. (auth)

20603 (LF-44, pp 287-90) EFFECT OF CHRONIC EXPOSURE TO ^{60}Co ON THE FREQUENCY OF METAPHASE CHROMOSOME ABERRATIONS IN THE LIVER CELLS OF THE CHINESE HAMSTER (IN VIVO). Brooks, A. L.; Meade, Diane K.; Peters, R. F. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The frequency of chromosome aberrations in the Chinese hamster liver was measured following protracted whole-body exposure to ^{60}Co γ rays. There was a linear increase in the aberrations/cell frequency with a coefficient of 3.3×10^{-4} aberrations/cell/rad. Over the range of dose-rates and the times studied, there was no dose-rate or time effect on this endpoint. However, when these data were compared with those from acute ^{60}Co γ irradiation studies, the acute exposure schedule was four times as effective in producing aberrations as protracted exposure. The frequency of ring plus dicentric aberrations increased as the 1.4 power of the dose and showed a dose-rate effect within the protraction study as well as between the protracted and acute radiation schedules. This study provides evidence for a marked dose-rate effect for the production of chromosome damage when very high dose-rates are compared to low dose-rates. However, protraction of the dose from 6 to 42 days or from 154 to 14 rads/day had little effect on the total aberration frequency. (auth)

20604 (NYO-2579-22) EXPOSURE OF FREE-RANGING CHIPMUNKS TO 200 AND 400 R OF GAMMA RAYS. Tryon, C. A. (Pittsburgh Univ., Pa. Pymatuning Lab. of Ecology); Snyder, D. P. (Massachusetts Univ., Amherst. Dept. of Zoology). [nd]. Contract AT(11-1)-3426. 19p. (CONF-710501-48). Dep. NTIS.

From third National symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Free-ranging individuals of the eastern chipmunk (Tamias striatus) were marked and subsequently live-trapped throughout their lifetime to obtain survival data under various treatments. Chipmunks were exposed to 200 and 400 R doses of gamma radiation and graphs are presented to show survival of males and females over a period of six months. It was found that the effect of radiation on the curve was to displace it upward and to straighten it. An analysis of variance was carried out on the effects of location, birth, sex, and radiation on survival curves. The following causes for the curve changes are suggested: bias in age specific mortality rates at different times during the 1962 to 1970 period; life lengthening due to increased physiological resistance to disease or aging; change in accessibility to predators or other environmental mortality; and change in emigration rates. (H.L.W.)

20605 EXPERIMENTAL STUDY ON THE FREQUENCY OF EARLY STRUCTURAL CHANGES OF THE LYMPHOCYTES CIRCULATING IN THE PANIRRADIATED RAT, AS A FUNCTION OF EXPOSURE AND OTHER PHYSICAL AND BIOLOGICAL PARAMETERS. Martinenghi, C.; Bergonzi, M.; Fidanza, M. A.; Comotti, L.; The, S. K. (Univ., Milan). Med. Nucl.-Radiobiol. Lat.; 12: No. 2, 109-22(1969). (In Italian).

Early structural changes induced in the nuclei of the circulating lymphocytes of the rat were examined following fractionated dose whole-body x irradiation. The effects of radiation dose, panirradiation, as an interval of time between exposures, blood sampling method, and incubation time of the blood at 37°C were studied. The morphological changes of lymphocytes consisted in a homogenisation of the structure of the nuclei, which represents an early expression of more serious changes (piknosis, caryolysis, caryorexy) which developed in damaged lymphocytes. Factorial analysis of the experimental data showed that each of the three factors considered, as well as their interactions, caused statistically significant differences in the frequency of deteriorations of the lymphocyte nuclei. (auth)

20606 SENSITIVITY OF MICE TO RADIOPROTECTORS FROM THE AMINO THIOL AND INDOLYL ALKYL AMINE SERIES DURING THE AFTEREFFECT OF TRANSVERSE OVERLOADS. Antipov, V. V.; Vasin, M. V.; Davydov, B. I.; Saksonov, P. P.; Smirnova, N. V. Probl. Kosm. Biol.; 14: 53-7(1971). (In Russian).

Mice were subjected to the action of overloads (centrifugation; 10 and 30 units, 15 min; 40 units, 10 min), and cystamine dihydrochloride (I; 180 to 350 mg/kg), S, β-aminoethylisothiouronium bromide (AET; 160 to 220 mg/kg), 5-methoxytryptamine (II; 180 to 240 mg/kg), or monosodium salt of β-aminoethylthiophosphoric (III; cystaphos; 800 to 1200 mg/kg) was injected intraperitoneally 5 min to 24 hrs later. A slight increase in resistance to the amino thiols (I, III) was noted immediately after centrifugation, and a reliable increase in sensitivity to I and AET in 30 min; the reaction of the animals returned to normal in 1 hr. II, administered one day after overload, raised the animals' resistance. The animals' resistance to I rose with an increase in the intensity of the overloads. (JPRS)

20607 EARLY BEHAVIORAL EFFECTS OF IONIZING RADIATION ON FOUR SPECIES OF SUBHUMAN PRIMATES. McMillan, Grant R.; Falkenberg, Steven D.; Thompson, W. D. (Baylor Univ., Waco, Tex.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 7-8(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

20608 THEORY OF RADIATION DOSE-SURVIVAL CURVES FOR THE CASE WHERE ORGANISM LETHALITY IS DEFINED AS LOSS OF REPRODUCTIVE CAPACITY. Craig, A. G. (Univ. of Salford, Eng.). J. Theor. Biol.; 32: No. 2, 259-67(Aug 1971).

Loss of reproductive capacity is the lethal mechanism most sensitive to radiation, and consequently the controlling mechanism of the dose-survival curve, for a wide range of organisms. A simple model of an organism consistent with this fact is used, with two postulates concerning the statistical nature of the radiation damage, to develop a general expression for the dose-survival curve controlled by this mechanism. The analysis leads to a number of deductions concerning the shape of survival curves and indicates how the radiation sensitivity may be considered as the product of two terms, one dependent on the organism alone and the other on the type of radiation. The general formula is expanded in terms of Poisson distributions to give an expression that could be applicable to cells. A number of tables are included to illustrate this case numerically. (auth) (UK)

20609 RADIOSENSITIVITY OF CELLS FORMING COLONIES UNDER THE CONDITIONS OF ACTIVATED AND INHIBITED ERYTHROPOIESIS. Michailov, V.; Zografov, D. G.; Mitrov, G. G. Radiobiol.-Radiother.; 12: No. 5, 627-32(1971). (In German).

Erythropoiesis was stimulated by loss of blood and inhibited by starvation in mice and the effect of these conditions on the radiosensitivity of colony-forming cells in the spleen was studied. In the starving animals the number and distribution of colonies did not differ from those of controls. In the animals with stimulated erythropoiesis there was an increase in the colonies of erythroblasts in the spleen. This increase was related to a decreased radiosensitivity of the colony-forming cells. A graph is presented to show the effects of radiation dose on the number of spleen colonies in control and starving animals. (H.L.W.)

20610 EFFECT OF 950R WHOLE-BODY GAMMA IRRADIATION ON SOME HEPATIC DRUG METABOLIZING SYSTEMS IN MICE. Shysh, A.; Noujaim, A. A. (Univ. of Alberta, Edmonton). Can. J. Pharm. Sci., 5: No. 2, 46-9(1970).

Groups of mice were exposed to 950R of gamma irradiation and the hepatic microsomal systems were examined for aniline p-hydroxylase and aminopyrine N-demethylase activities, microsomal protein content, and cytochrome P-450 levels at various post-irradiation intervals. A stimulation of in vitro metabolism of aniline and aminopyrine was noted on the first and third post-irradiation days followed by a sharp decline by the fifth day and further depression throughout the remainder of the 13 day observation period. Levels of microsomal cytochrome P-450 were elevated on day 1, returned to normal by day 3 and subsequently continued to decrease below control values for the duration of the experiment. Microsomal protein content after 950R followed a cyclic pattern; an increase on the first and third day, a reduction on the seventh day and a return to normal by the thirteenth day. (auth)

20611 POLYDIPSIA AND POLYURIA IN WHOLE-BODY IRRADIATED RATS: A COMPARISON WITH "PAIR-FASTED" ANIMALS. Scoppa, P.; Marafante, E. (Euratom Joint Research Center, Ispra, Italy). Arch. Sci. Biol. (Bologna); 54: 35-44 (Jan-Mar 1970).

It has been shown that the modifications of water exchange in whole-body irradiated rats are partially dependent on the state of anorexia characteristic of the post-irradiation period. In comparison with "pair-fasted" animals, both polydipsia and polyuria of sublethally x-irradiated rats are not restricted to the first 24 hours after exposure to radiation, but persist for at least 96 hours. Urine concentration in whole-body irradiated animals is strongly reduced, while in "pair-fasted" controls it is only 25% below normal values. (auth)

20612 IMMUNOGENESIS IN IRRADIATED ANIMALS. Kartashov, P. A. Veterinariya; No. 4, 46-7(1971). (In Russian).

Immunity was studied in sheep immunized 1 week, 1, 3, and 6 to 12 months after whole-body irradiation with lethal doses. Polyvalent sheep paratyphoid vaccine was used as the antigen and the animals received a radioprotective agent prior to exposure. Specific antibodies were found in animals vaccinated a week after irradiation, but immunity was weaker than in non-irradiated animals. In sheep vaccinated a month after irradiation, antibody formation started at the same times as in controls. In the production phase, antibodies were formed slowly after the first vaccination but rapidly after the second. Immunity was the same as in controls. In sheep vaccinated after 3 months, antibody formation started at the same time as in controls, but in the production phase the rate of increase was slower and 30 days after vaccination, the agglutinin titer in irradiated animals was half that in controls. In animals vaccinated 6 to 12 months after irradiation with 400 to 600 R (with prior injection of a radioprotective agent) or 540 R fractionally without the radioprotective agent (the dose was not lethal), antibody production started at the same time as in controls, but the rate was slower in the production phase. (JPRS)

20613 METABOLISM OF 5-HYDROXYTRYPTOPHAN IN ISOLATED PERFUSED LIVER FROM NORMAL AND X-IRRADIATED RATS. Gerber, G. B.; Deroo, J. (SCK/CEN, Mol, Belg.). Biophysik; 8: No. 1, 9-18(30 Dec 1971).

Metabolism of ^{14}C-5-OH-tryptophan was studied in isolated perfused liver from normal and whole body irradiated rats (7 to 8 days after 1000 R). Metabolism of 5-OH-tryptophan is slow compared to that of 5-OH-tryptamine, and the metabolites isolated were mainly conjugates of 5-OH-tryptamine and 5-OH-indole acetic acid. Irradiation does not diminish significantly the conversion of 5-OH-tryptophan to 5-OH-tryptamine, rather an increased formation of 5-OH-indole acetic acid and of conjugates could be observed in irradiated liver. (auth)

20614 EFFECT OF IONIZING RADIATION ON THE CHROMOSOMES IN MEIOTIC AND MITOTIC CELLS. Wennstroem, J. (Folkhaelsan Inst. of Genetics, Helsinki). Comment. Biol.; No. 45, 1-60(1971).

Thesis.

Male albino mice of the NMRI (Naval Medical Research Institute, Bethesda) were used as test animals. The appearance and frequency of various types of chromosome aberration were assessed in male germ cells at diakinesis and metaphase I of meiosis at different times after x-irradiation. For the sake of comparison, bone marrow and corneal cells at metaphase of mitosis were similarly studied. Dose-response curves for the chromosome aberrations observed one day and two months after irradiation with different doses were calculated for the germ cells. The curves were non-linear. The frequency of univalents at diakinesis and metaphase I of meiosis increased with increasing x-ray dose one day after irradiation. The effect of fractionated irradiation of spermatogonia, performed at one day intervals, was studied at diakinesis and metaphase I of meiosis. (auth) (Finland)

20615 RELATIVE RADIOSENSITIVITY OF THE VISUAL AND SOMATOSENSORY SYSTEMS IN GUINEA PIGS. Bakradze, O. S. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 64: No. 2, 437-40(Nov 1971). (In Russian).

Relative radiosensitivity of the visual and somatosensory systems was studied. Experiments were carried out on unanesthetized and unrestrained guinea pigs. The cortical responses to visual stimuli were abolished at doses of 13 to 18 krads, while those induced by electrical skin stimulation persisted until the death of the animal. The data obtained showed that the changes occurring in the visual system of guinea pigs are induced by radiation damage of the retina. (auth)

20616 EFFECT OF BETA IRRADIATION ON THE FUNCTION OF THE FOLLICLE STIMULATING HORMONE IN THE FEMALE INDIAN DESERT GERBIL, MERIONES HURRIANAE JERDON. Srivastava, P. N.; Ramesharao, A. (Rajasthan Univ., Jaipur, India). Bull. Nat. Inst. Sci. India; No. 36, 68-74(1968).

Endogenous beta-irradiation at suitable sublethal dose levels elicits ovarian lesions in the female Indian desert gerbil, M. hurrianae. The present experiment shows that beta-irradiation at the given dose level (2 μc of ^{32}P plus 2 μc of ^{45}Ca/gm body wt.) evokes ovarian involution and profuse follicular atresia after one month. These animals when treated with 2.5 mg of FSH for 72 hr, showed that the response of the irradiated ovary to exogenous gonadotropin is reduced as evidenced by the reduction in wt. of ovaries and uteri, and also by the relative number of follicles. (Indian Sci. Abstr.)

Invertebrates

20617 (CONF-700909-, pp 434-53) INSECT-INDUCED AGROECOLOGICAL IMBALANCES AS AN ANALOG TO FALLOUT EFFECTS. Stern, Vernon M. (California Univ., Riverside). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Many species in the classes Insecta and Arachnida are phytophagous and compete with man and his domestic animals for food, and others attack man and animals directly or transmit plant and animal diseases. On the other hand, there are tremendous numbers of beneficial species; among them are plant pollinators, insects that aid in the decomposition and recycling of plant and animal debris, and thousands of other beneficial insects and mites that attack and kill the destructive species. Crop losses from insects amount to nearly $4 billion annually. Control measures (mainly chemicals) for crop protection in the field and for stored crop products cost nearly $750 million annually. Many insect-pest populations rise to damaging levels year after year in agroecosystems although this is rather uncommon in natural communities. The monoculture is a special type of agroecosystem resulting from man's technical efforts to control nature to meet his need for food and other products. It is somewhat doubtful whether we can change the monoculture into a more diversified agroecosystem despite the annual plagues of insect pests. Fallout radiation is somewhat similar to the pesticides that often cause ecological disruptions. Even though pest insects may be eliminated from certain areas by fallout radiation, they can be expected to become reestablished in these areas soon and again to compete with man for his food. For these and other reasons discussed, both beneficial and pest species will be important factors in food production in the event of nuclear war. (auth)

20618 (CONF-700909-, pp 509-20) RESPONSES OF SOME GRASSLAND ARTHROPODS TO IONIZING RADIATION. Styron, Clarence E.; Dodson, Gladys J. (Oak Ridge National Lab., Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Responses of arthropod communities to ionizing radiation and the interactions of radiation with other environmental parameters are being investigated in studies of biological and physical dosimetry of β and γ radiation from simulated fallout in a grassland area, long-term field observations on interactions of the fallout radiation with seasonal changes in composition and structure of the arthropod community, and short-term laboratory studies on interactions of fallout radiation with population dynamics of selected insect species. Beta- and γ-radiation levels in the simulated fallout area were determined by thermoluminescent dosimetry. Lithium fluoride microdosimeters attached to grasshoppers and crickets in the fallout field indicated that these closely related organisms received significantly different radiation doses owing to differences in habitat. Numbers of soil-, litter-, and grass-inhabiting arthropods collected in the simulated-radioactive-fallout field varied significantly among months and taxa. There was no significant difference in variation between arthropod communities of field enclosures before application of the simulant. The only significant differences among numbers of individuals in taxa comprising the arthropod communities of control and contaminated areas occurred four months after contamination. No significant increase in species composition dissimilarity between the contaminated and control areas appeared during the second year following application of the fallout. Consequently, the threshold for effects of fallout radiation on species composition of the arthropod community must be above the ~13 rads/day delivered over this time. Data on exposure of laboratory populations of Folsomia (Collembola) to β radiation from $^{90}Sr-^{90}Y$ fallout indicate that population dynamics were affected primarily by sensitivity of fertility rates rather than by sensitivity of adults. Dose rates estimated to give an $LD_{50/30}$ or $LD_{50/60}$ for adults were more than twice as high as dose rates required to reduce fertility rates to zero. (auth)

20619 (CONF-700909-, pp 521-6) SURVIVAL OF CRICKETS, ACHETA DOMESTICUS (L.), AS AFFECTED BY VARIATIONS IN GAMMA DOSE RATE. Van Hook, R. I. Jr. (Oak Ridge National Lab., Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Effects of 5000 rads of γ radiation delivered at five different dose rates on the survival of young adult crickets, Acheta domesticus (L.), were determined. Significant ($P \leq 0.05$) differential mortality occurred as a function of dose rate. Lower dose rates resulted in reduced mortality. Mortality increased with increasing dose rate up to 200 rads/hr, above which further increases in irradiation intensity produced very similar mortality rates. (auth)

20620 (CONF-700909-, pp 527-34) EFFECTS OF BETA-GAMMA RADIATION OF EARTHWORMS UNDER SIMULATED-FALLOUT CONDITIONS. Reichle, David E.; Witherspoon, John P.;

Mitchell, Myron J.; Styron, Clarence E. (Oak Ridge National Lab., Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Experiments on ^{60}Co γ and $^{90}Sr-^{90}Y$ β radiosensitivity of Lumbricus terrestris and dosimetry models of soil systems were designed to study the effects of fallout radiation on natural earthworm populations. Epithelial tissues (skin and/or intestinal) were the primary sites for radiation damage. The $LD_{50/30\ days}$ for γ was 67.8 krads; no significant increase in mortality occurred for β irradiations up to 102.4 krads. In situ dosimetry models with ^{137}Cs show that β radiation is important only for direct contact (because of soil shielding) and that γ radiation typically would contribute from 68 to 100% of the external body dose of natural populations. Habitat shielding, high radioresistance of earthworms, and radioactive decay preceding particle incorporation into soil suggest minimal population mortality due to radiation from anticipated weapon yields. (auth)

20621 SOME EFFECTS OF GAMMA RADIATION ON EARWIGS IN ONTARIO, CANADA (DERMAPTERA: FORFICULIDAE). Wilson, W. A.; Wilde, W. H. A. (Univ. of Guelph, Ont.). Can. Entomol.; 103: No. 8, 1201-6(Aug 1971).

Effects of varying levels (4 to 132 krad) of gamma radiation on moulting, feeding, co-ordination and locomotion, and wing development in Forficula auricularia L. are described and illustrated. A radiation profile shows the increased radiosensitivity of nymphs as compared to adult F. auricularia. (Canada)

20622 STERILISATION OF MALES OF THE LARCH BUD MOTH ZEIRAPHERA DINIANA BY γ-RAYS. Benz, G. (Swiss Federal Inst. of Tech., Zurich). Experientia; 27: No. 9, 1093-6 (15 Sep 1971).

Experiments were conducted to establish the radiation dose needed for sterilization of male moths. Male pupae were irradiated with different doses of gamma rays one to two days before eclosion. Doses up to 40 kR did not interfere with eclosion and morphological differentiation of the moths. Doses of 60 kR reduced the hatchability and the spreading of the moth's wings only slightly, whereas doses of 80 kR had a strong negative effect. Mating experiments showed that the percentage of inseminated eggs was significantly reduced when the males were irradiated with 40 kR and became zero with 80 kR. When F_1 offspring of males irradiated with 20 kR were crossed with offspring of males exposed to 40 kR practically no progeny were produced. Results suggest that the sterile male technique might be applicable for the control of the larch bud moth. (H.L.W.)

Radionuclide Effects (Internal Source)

Refer also to abstracts 20632 and 20662.

20623 ISOTOPE EFFECTS IN BIOLOGY. PART. II. BIOLOGICAL OBSERVATIONS AND APPLICATIONS. Lacroix, Marcel (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 40: No. 3-4, 179-98(1971). (In French).

A review of the literature on radioisotope applications and effects in biological research is presented. Studies on microorganisms include research on bacteria, yeasts, and algae using ^{13}C, deuterium oxide, ^{2}H, ^{6}Li, ^{7}Li, ^{14}N, and ^{34}S. Studies are reviewed on higher plants in which the following isotopes are used: ^{2}H, ^{14}N, ^{15}N, ^{16}O, and ^{18}O. Studies using ^{13}C on the role of carbon dioxide in photosynthesis and respiration are discussed. Studies are reviewed on the role of ^{13}C, ^{18}O, and ^{34}S in shell formation of molluscs and variations in ^{13}C and ^{18}O in the shells of crustaceans and echinoderms are discussed. Reviews are also given of the use of tracers in biology, errors due to disregard of isotopic effects, and toxicity of stable isotopes. (H.L.W.)

Man

20624 (CONF-700909–, pp 548-65) SIGNIFICANCE OF LONG-LIVED NUCLIDES AFTER A NUCLEAR WAR. Russell, R. Scott; Bartlett, B. O.; Bruce, R. S. (Agricultural Research Council, Wantage (England). Letcombe Lab.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

The radiation doses from the long-lived nuclides ^{90}Sr and ^{137}Cs, to which the surviving population might be exposed after a nuclear war, are considered using a new evaluation of the transfer of ^{90}Sr into food chains. As an example, it is estimated that, in an area where the initial deposit of near-in fallout delivered 100 R/hr at 1 hr and there was subsequent worldwide fallout from 5000 Mt of fission, the dose commitment would be about 2 rads to the bone marrow of the population and 1 rad to the whole body. Worldwide fallout would be responsible for the major part of these doses. In view of the possible magnitude of the doses from long-lived nuclides, the small degree of protection that could be provided against them, and the considerable strain any such attempt would impose on the resources of the community, it seems unrealistic to consider remedial measures against doses of this magnitude. Civil-defense measures should be directed at mitigating the considerably higher doses that short-lived nuclides would cause in the early period. (auth)

20625 ACCIDENTAL INTAKE OF TRITIATED WATER. Lambert, B. E.; Sharpe, Heather B. A.; Dawson, K. B. (Radiological Protection Service, Sutton, Eng.). Amer. Ind. Hyg. Ass. J.; 32: No. 10, 682-6(Oct 1971).

Data on an accidental intake of tritium that resulted in about 400 mCi of tritium distributed throughout the body water of one man is presented. The urinary excretion and loss of tritium from blood were followed for a period of time that allowed a precise estimate of dose to blood and body tissues to be calculated. In addition, lymphocyte chromosome aberrations were scored in blood samples and attempts were made to correlate dose and aberration yield. The reasons for the difficulties involved in dose-effect correlations in such cases are discussed. (auth)

20626 EVALUATION OF THE DOSE ABSORBED BY PATIENTS SUBMITTED TO KIDNEY FUNCTION RESEARCHES WITH RADIOISOTOPE METHODS. Conte, L.; Mombelli, L. (Univ., Milan). Med. Nucl.-Radiobiol. Lat.; 12: No. 2, 95-107(1969). (In Italian).

The radiation doses absorbed by total body, kidneys, gonads, and bladder in standard man following the administration of radioactive tracers labeled with ^{131}I, ^{125}I, ^{203}Hg, and ^{197}Hg were calculated. The calculated factors were functions of radiation type, and physical and anatomical parameters of standard man; consequently they did not depend on the kinetics and physical half life of radioisotopes that influence the absorbed doses. On the basis of the calculated factors and kinetic parameters the absorbed doses in total body, gonads, kidneys and bladder of man were estimated after administration of ^{131}I Glomerfil for diagnostic purposes. (auth)

20627 DOSIMETRY OF COBALT RADIOISOTOPES IN MAN. Smith, T. (University Coll. Hospital, London). Health Phys.; 22: No. 1, 91-3(Jan 1972).

The retention of ^{60}Co, ^{58}Co, and ^{57}Co in man for periods up to 1000 days was compared with the ICRP mathematical model based on animal studies. Results indicated that the lower large intestine (LLI) was the critical organ for ingested cobalt radioisotopes and radioactivity values in this organ were used to calculate the MPC of the radionuclides in water. There was close agreement for ^{60}Co and ^{58}Co with the ICRP data, and the MPC for ^{57}Co was $\frac{1}{3}$ of the ICRP value. These results were attributed to the fact that the absorbed proportion of ingested radiocobalt was so small that the long-term whole-body retention of the absorbed radionuclide did not significantly influence the calculation of the dose to the LLI. However, the whole-body dose commitments following uptake of radiocobalt to the blood were considerably greater than those predicted by the ICRP retention model. (UK)

Animals

Refer also to abstracts 20663 and 20664.

20628 (CONF-700909–, pp 178-92) SIMULATED-FALLOUT-RADIATION EFFECTS ON SHEEP. Sasser, L. B.; Bell, M. C.; West, J. L. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y (15 Sep 1970).

Sixty-four yearling lambs were exposed to the following radiation treatments: (1) ^{90}Y beta irradiation of the gastrointestinal tract (2.4 mCi/kg of body weight) for 3 consecutive days, (2) ^{90}Y beta irradiation of the skin (57,000 rads), (3) ^{60}Co irradiation of the total body (240 R), or (4) all possible combinations of these treatments. Irradiation of the gastrointestinal tract produced severe injury to the rumen and abomasum and resulted in severe anorexia and diarrhea and a significant loss (>20%) of body weight. Nearly 50% of the lambs subjected to combined gastrointestinal and whole-body irradiation died within 60 days, but lambs in other treatment groups were able to recover from the initial irradiation insult. Skin irradiation caused no immediate threat to life but affected survival several months postirradiation. Implications of multiple irradiation trauma on animal survival are discussed from a post-attack recovery viewpoint. (auth)

20629 (CONF-700909–, pp 193-207) SIMULATED-FALLOUT-RADIATION EFFECTS ON LIVESTOCK. Bell, M. C.; Sasser, B.; West, J. L. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Cattle ingesting ^{90}Y-labeled fallout simulant at the rate of 2 mCi/kg of body weight were more severely affected than those given 57,000 rads beta irradiation to 8% of the dorsal body surface. Whole-body irradiation of 240 R from ^{60}Co at 1 R/min affected only blood platelets and leukocytes. When these three treatments were combined on eight steers, all died within 54 days. Cattle were more sensitive to simulated-fallout radiation than sheep, but major damage from ingested radioactivity was in the rumen and abomasum of both species. No data were found on combined fallout-simulant effects on simple-stomach animals, but effects are predicted to be less than in ruminants. Sheltering cattle in barns would be the most effective practical measure to increase animal survival and reduce productivity losses in the survivors. Corralling animals to prevent their grazing heavily contaminated pastures would be an alternative where barns are not available. About 80% of the 112 million U. S. cattle are on pasture. In a 4-hr roundup time, it is estimated that this percentage could be reduced to 34% by corralling about 43 million cattle and by placing about 31 million in barns. (auth)

20630 (CONF-700909–, pp 208-23) PATHOLOGY OF GASTROINTESTINAL-TRACT BETA-RADIATION INJURY. West, J. L.; Bell, M. C.; Sasser, L. B. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Fifty-five wether lambs of mixed breeding and seventeen yearling grade Hereford steers fed ^{90}Y-labeled sand as a fallout simulant developed characteristic lesions, particularly in the upper digestive tract. These changes occurred in selective areas in the stomach compartments. Typically there were large, friable, yellowish, elevated areas of fibrino-necrosis in the rumen sacs; areas of fibrino-necrosis or hemorrhagic necrosis in the reticulum; small hematomas, linear erosions, and focal yellowish necrotic exudate in the omasum; and areas of hemorrhagic necrosis in the abomasum. Healing occurred by scar-tissue formation. Scars in many instances had tags of necrotic exudate and/or superficial erosions months later. Changes in the reticulum and omasum were of appreciably higher incidence and severity in the steers than in sheep. Intestinal lesions were also of increased incidence and severity in steers as compared to sheep. Exposure of animals to beta skin-plaque irradiation in addition to feeding radionuclide did not significantly influence gastrointestinal-tract involvement, but whole-body irradiation exerted a definite additive effect. The conclusion that steers are more sensitive to the effects of the irradiation procedures employed than are sheep appears to be valid. (auth)

20631 (CONF-700909–, pp 535-47) ^{137}Cs ACCUMULATION, DOSIMETRY, AND RADIATION EFFECTS IN COTTON RATS. Digregorio, D.; Dunaway, P. B.; Story, J. D.; Kitchings III, J. T. (Oak Ridge National Lab., Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Cesium-137 accumulation, dosimetry, and radiation effects were determined in cotton rats living in their natural environment, which was contaminated with ^{137}Cs-labeled sand. Cesium-137 levels were relatively high 6 months after application of the fallout simulant but decreased as the simulant descended from the vegetation toward the ground. Radioactivity levels in organs and tissues, in general, paralleled those of the whole body. Dose rate to cotton rats paralled radioactivity levels in the whole body. No effects on peripheral blood or body weight due to irradiation were observed in this study. (auth)

20632 (LF-44, pp 121-5) TOXICITY OF INHALED $^{90}SrCl_2$ IN BEAGLE DOGS. V. Benjamin, S. A.; Boecker, B. B.; Chiffelle, T. L.; Hobbs, C. H.; Jones, R. K.; McClellan, R. O.; Pickrell, J. A.; Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Studies on the metabolism, dosimetry, and effects of inhaled $^{90}SrCl_2$ in the Beagle dog are continuing in an effort to provide a basis for assessing the consequences of inhaling ^{90}Sr such as might be released in certain nuclear accidents. Seventy-two dogs have been exposed to aerosols containing ^{90}Sr, resulting in initial body burdens ranging from 2.6 to 280 μCi ^{90}Sr/kg. Forty-eight of these dogs are being maintained for lifetime observation. The long-term retained burdens in these dogs range from 1 to 120 μCi ^{90}Sr/kg. Twenty-four dogs with a mean long-term retained burden of 38 μCi ^{90}Sr/kg have been assigned to a sacrifice study. Two of these dogs were sacrificed at five days, two at one month, and two at one year after inhalation of ^{90}Sr. To date, 29 dogs have died or were euthanized, six during the first 31 days after inhalation of ^{90}Sr with severe hematologic dyscrasia and 23 between 585 days and 2264 days after inhalation of ^{90}Sr. The latter group includes 10 with angiosarcomas, three with fibrosarcomas, seven with osteosarcomas, two with osteochondrosarcomas, one with osteochondrofibrosarcoma, one with leukemia, one with an epileptic seizure, and one with cerebellar hemorrhage (three dogs had both an angiosarcoma and an osteosarcoma). The skeletons of these dogs received initial radiation dose rates of 13 to 55 rads/day and cumulative doses to death of 4,000 to 22,000 rads. Serial observations are continuing on 37 surviving ^{90}Sr dogs and 22 control dogs. (auth)

20633 (LF-44, pp 126-35) TOXICITY OF INHALED $^{144}CeCl_3$ IN BEAGLE DOGS. V. Boecker, B. B.; Benjamin, S. A.; Chiffelle, T. L.; Jones, R. K.; Hobbs, C. H.; McClellan, R. O.; Pickrell, J. A.; Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Studies on the metabolism, dosimetry, and effects of inhaled $^{144}CeCl_3$ in the Beagle dog are continuing in an effort to provide information that will aid in assessing the biological consequences of inhaling ^{144}Ce such as might be released in certain nuclear accidents. Studies on the tissue distribution of inhaled $^{144}CeCl_3$ indicate that ^{144}Ce deposited in the lung is translocated at a moderately rapid rate to liver and skeleton. The pattern of distribution is such that significant radiation doses are accumulated by all three tissues. Fifty-five dogs that inhaled $^{144}CeCl_3$ and 15 control dogs have been placed in a longevity study and will be observed for their lifespan. The ^{144}Ce dogs had initial lung burdens ranging from 20 to 2800 μCi. Twenty-one dogs have died; eight at 21 to 44 days post-inhalation with signs attributed to severe bone marrow damage and associated pancytopenia; two at 138 and 144 days with radiation pneumonitis; three at 309 to 874 days with hepatic necrosis; one at 510 days with marrow aplasia; one at 375 days with pulmonary fibrosis; and six at 799 to 1826 days with obvious neoplasms or myeloproliferative disorders. One of the last six dogs had an osteosarcoma, another had a squamous cell carcinoma of the maxilla and a small papillary adenoma of the lung, another had a hemangiosarcoma of the liver, two had myelogenous leukemia, and one had myelofibrosis with myeloid metaplasia. Serial observations are continuing on the 34 surviving $^{144}CeCl_3$ dogs and 15 control dogs. (auth)

20634 (LF-44, pp 136-8) TOXICITY OF INHALED $^{91}YCl_3$ IN BEAGLE DOGS. V. Redman, H. C.; Benjamin, S. A.; Boecker, B. B.; Hobbs, C. H.; Jones, R. K.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Studies on the metabolism, dosimetry, and effects of inhaled $^{91}YCl_3$ in Beagle dogs are continuing with a view to providing information that will assist in assessing the biological consequences of nuclear accidents in which ^{91}Y or other radionuclides that produce a similar radiation dose pattern may be released. Forty-two dogs with ^{91}Y burdens from 73 to 1300 μCi/kg were placed in four groups with mean initial body burdens of 120, 260, 560, and 920 μCi/kg. For comparison with observed biological effects, these same dogs were regrouped on the basis of retained 14-day body burdens yielding groups with mean values of 30, 58, 140, and 270 μCi/kg. These dogs and 12 control dogs are being maintained for lifetime observation. An additional four dogs with mean initial ^{91}Y burdens of 560 μCi/kg were placed in a sacrifice study. Eleven dogs within the highest exposure groups have died or were euthanized at 17 to 33 days after inhalation of ^{91}Y with changes related to severe bone marrow damage and associated pancytopenia. Two dogs died approximately one year after ^{91}Y inhalation with convulsive seizures that were presumed to be unrelated to the ^{91}Y exposure. Thirty-three dogs that had initial lung burdens of 73 to 660 μCi/kg and all 12 control dogs are surviving at 1500 days or more after inhalation of ^{91}Y. Serial observations are continuing on all surviving dogs. (auth)

20635 (LF-44, pp 139-44) TOXICITY OF INJECTED ^{137}CsCl IN THE BEAGLE DOG. IV. Redman, H. C.; Benjamin, S. A.; Boecker, B. B.; Jones, R. K.; McClellan, R. O.; Pickrell, J. A.; Hobbs, C. H. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Studies on the metabolism, dosimetry, and effects of intravenously administered ^{137}CsCl in the Beagle dog are being conducted to aid in assessing the biological consequences of exposure to ^{137}Cs such as might occur in the event of certain nuclear ac-

cidents. The effects of the chronic, relatively uniform whole-body exposure produced by ^{137}Cs are compared with other diverse radiation dose patterns resulting from inhalation of radioactive aerosol. Sixty-six dogs were entered into the study, six with a mean initial ^{137}Cs body burden of 3700 μCi/kg, and 12 dogs each with mean initial ^{137}Cs body burdens of 2820, 1940, 1420, 970, and 0 μCi/kg. All six of the highest level dogs died at 19 to 33 days post-injection with cumulative whole-body doses of 950 to 1400 rads. Three dogs in the 2820 μCi/kg level died at 24 to 27 days post-injection with cumulative whole-body doses of 860 to 910 rads. One dog in the 2820 μCi/kg level and one dog in the 1940 μCi/kg level died at 77 and 81 days after injection with cumulative whole-body doses of 1300 to 1400 rads. These early deaths were attributed to severe bone marrow damage which was reflected in an early dose-related pancytopenia. A dog injected with 1900 μCi ^{137}Cs/kg died acutely at 693 days post-injection with necropsy findings attributed to shock. A control dog died 647 days after being placed on the study with clinicopathological manifestations of an auto-immune hemolytic anemia. Forty-two ^{137}Cs dogs and 11 controls are surviving at 951 to 1205 days after being placed on experiment. The surviving ^{137}Cs dogs had initial body burdens that ranged from 880 to 3000 μCi/kg and received cumulative whole-body doses of 550 to 2200 rads. Serial observations are continuing on all survivors. (auth)

20636 (LF–44, pp 145-50) TOXICITY OF INHALED ^{90}Y FUSED CLAY IN BEAGLE DOGS. III. Hobbs, C. H.; Barnes, J. E.; Chiffelle, T. L.; Hahn, F. F.; Jones, R. K.; Mauderly, J. L.; McClellan, R. O.; Pickrell, J. A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Studies on the metabolism, dosimetry, and effects of inhaled ^{90}Y in fused clay aerosols in the Beagle dog are being continued with a view toward assessing the consequences of inhalation of an energetic beta emitter that has a short effective half-life in the lung. Two major studies are being performed: a radiation dose pattern study in which 12 dogs were sacrificed in pairs at 0, 2, 4, 6, 8, and 12 days post-inhalation exposure; and a longevity study in which 89 dogs have been exposed to ^{90}Y fused clay to date with initial lung burdens ranging from 80 to 5,200 μCi/kg and 12 control dogs were exposed to stable yttrium in fused clay. The ^{90}Y was retained in lung with a half-life that approximated the physical half-life with only small quantities translocated to tracheobronchial lymph nodes, skeleton, and liver. The infinite radition doses to lung, tracheobronchial lymph nodes, skeleton, and liver, for an initial lung burden of 1 mCi, were estimated to be 1200, 170, 0.54, and 0.38 rads, respectively, normalized to a 10-kg dog. One mCi deposited in the upper respiratory tract and cleared via the gastrointestinal tract was estimated to result in a dose of 38 rads to the colon. Thirty-five of 39 dogs with cumulative doses to lung from 7,300 to 55,000 rads died from 7.5 to 220 days post-exposure and the surviving four dogs in this dose range are showing signs of severe pulmonary insufficiency at 184 to 380 days post-exposure and are not expected to be long-term survivors. All the dogs that have died have shown clinico-pathologic features consistent with radiation pneumonitis. Two dogs with doses to lung of 6,100 and 6,200 rads have radiographic lesions consistent with mild pulmonary fibrosis. Forty-eight exposed dogs with doses to lung from 990 to 5,700 rads are surviving with no detectable clinical signs at from 182 to 735 days post-exposure and will be studied for the remainder of their lifespan. (auth)

20637 (LF–44, pp 181-92) TOXICITY OF INHALED ^{90}Sr FUSED CLAY IN BEAGLE DOGS. II. Barnes, J. E.; Boecker, B. B.; Hahn, F. F.; Hobbs, C. H.; Jones, R. K.; Mauderly, J. L.; McClellan, R. O.; Pickrell, J. A.; Snipes, M. B. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Studies on the metabolism, dosimetry, and effects of inhaled ^{90}Sr fused clay aerosols in Beagle dogs have been continued with a view to obtaining information on the biological consequences of inhaling this important radionuclide in a relatively insoluble form. Moreover, the radiotoxicity of inhaled ^{90}Sr fused clay is of interest as it represents a long effective half-life beta-emitter which might be deposited in lungs. Two major studies are in progress: a radiation dose pattern study with dogs scheduled for serial sacrifice from 0 to 2560 days post-inhalation exposure; and a longevity study in which dogs will be observed for their lifespan. Dogs in the radiation dose pattern study have been sacrificed at time intervals of up to 512 days post-inhalation exposure. After an early rapid clearance of ^{90}Sr deposited in large airways and the nasopharynx, the majority of the remaining ^{90}Sr is retained in lung with an effective half-life of 435 days. To date, 72 dogs with initial lung burdens of 3.8 to 100 μCi ^{90}Sr/kg body weight and 12 control dogs exposed to non-labeled fused clay have been entered into the longevity study. Twenty-six deaths have been observed in longevity dogs exposed to achieve initial lung burdens of 33 μCi/kg or greater. Death occurred between 159 and 477 days post-inhalation exposure after a cumulative dose to the lungs ranging from 34,000 to 82,000 rads. (auth)

20638 (LF–44, pp 193-5) TOXICITY OF BETA-EMITTING RADIONUCLIDES INHALED IN FUSED CLAY PARTICLES BY BEAGLE DOGS. McClellan, R. O.; Barnes, J. E.; Boecker, B. B.; Hahn, F. F.; Hobbs, C. H.; Jones, R. K.; Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The current status of studies in which Beagle dogs have been exposed to aerosols of ^{90}Y, ^{91}Y, ^{144}Ce, and ^{90}Sr in fused clay is reviewed. These radionuclides are avidly retained in the lung with biological half-times of 450 to 710 days with effective half-times of 53,200, and 435 days for ^{91}Y, ^{144}Ce, and ^{90}Sr, respectively. With the passage of time, small quantities of all the radionuclides are translocated to tracheobronchial lymph nodes, and to other tissues dependent upon the elemental chemical character of the radionuclide. Translocated ^{91}Y is found primarily in skeleton and liver, ^{144}Ce in liver and skeleton, and ^{90}Sr in skeleton. Three hundred and sixty-eight dogs have been exposed via inhalation to achieve graded initial lung burdens of the radionuclides. An additional 51 dogs have been exposed to non-radioactive labeled clay and serve as controls. One hundred and five dogs have died or been euthanized at seven to 1318 days post-inhalation exposure with the survival time and cumulative doses to lung at death being dependent upon the initial dose rate and the rate of decrease of the beta radiation dose rates to lung. The earliest deaths and lowest cumulative doses to lung at death were observed in the dogs that inhaled ^{90}Y fused clay. One hundred and one dogs died at less than 500 days post-inhalation exposure with death related to radiation pneumonitis and pulmonary fibrosis. Four dogs in the ^{144}Ce fused clay study died at 750 to 1318 days post-inhalation exposure with pulmonary neoplasms. These lifespan studies are being continued. (auth)

20639 (LF–44, pp 196-203) METABOLISM, DOSIMETRY, AND BIOLOGICAL EFFECTS OF INHALED ^{241}Am IN BEAGLE DOGS. Thomas, R. G.; McClellan, R. O.; Thomas, Randi L.; Chiffelle, T. L.; Hobbs, C. H.; Jones, R. K.; Mauderly, J. L.; Pickrell, J. A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Five beagle dogs were exposed by inhalation to an aerosol formed by passing liquid droplets containing ^{241}Am through a heating column at 600°C. One dog was frozen shortly post-inhalation and used as a counting standard; the remaining four were held for urine and feces collections for up to 138 days; they were sacrificed at 127, 256, 512, and 1022 days post-exposure. Initial α body burdens ranged from 4.4 to 4.9 μCi/kg. Tissue distribution analyses indicated the greatest long term doses were received by the tracheobronchial lymph nodes, liver, lung, bone, and thyroid in descending order. Respiratory measurements showed increased frequency and decreased tidal volumes in the two early-sacrifice dogs only. Hematologic findings included reduced total white cells, platelets, lymphocytes, and neutrophils, but little change in hematocrit. Pathologic findings centered around fibrotic changes in lung and lymph nodes, fatty deposits and cellular degeneration in liver, bone marrow depletion, glomerulosclerosis, and severely damaged thyroid. (auth)

20640 (LF–44, pp 204-10) TOXICITY OF INHALED ^{90}Y FUSED CLAY IN MICE. Lundgren, D. L.; Hahn, F. F.; Thomas, Randi L.; Sanchez, A.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The toxicity of inhaled ^{90}Y in fused clay aerosols is being investigated in mice to provide data for comparison with a similar study in Beagle dogs. A total of 17 groups of 40 to 60 mice each (949 mice) were exposed to aerosols of ^{90}Y in fused clay particles. Four hundred eighty-four of the mice were utilized in various sacrifice series and 465 with initial lung burdens (ILB) ranging from one to 136 μCi ^{90}Y were retained for lifespan observation. Following a rapid clearance of ^{90}Y in fused clay during the first few days post-inhalation a stable whole-body retention was reached by the seventh day when approximately 92% was retained in the lungs and 8% in the remainder of the carcass. Mice with IBL of approximately 60 μCi ^{90}Y and greater had all died within 21 days. The most significant histopathological observations in the mice that died between days seven and 10 was a loss of epithelial cells

in the esophagus and intestine and the resultant inflammatory response. Pulmonary lesions were minimal. In mice with ILB of 30 or more μCi ^{90}Y that died between 14 and 28 days, gastrointestinal lesions were not present but a mild to severe inflammatory response was present in the lungs. (auth)

20641 (LF-44, pp 211-18) TOXICITY OF ^{90}Sr CITRATE IN THE CHINESE HAMSTER. Brooks, A. L.; Benjamin, S. A.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Chinese hamsters were injected with 0.2, 0.5, 1.0, 2.0, 3.0, and 5.0 μCi ^{90}Sr in Na citrate/gm body weight and observed for their lifetime. Controls were injected with Na citrate and handled similarly. Following a rapid clearance stage, 10% of the ^{90}Sr was retained with an effective half-life of 600 days. The 0.5, 1.0 and 2.0 μCi ^{90}Sr/gm animals had a cumulative dose to the time of median survival of about 5000 rads. There was a lifespan shortening effect which increased with the level of ^{90}Sr activity injected with a coefficient of 75% life shortening/μCi/gm. Numerous pathological alterations were noted in both the control and treated animals. Three osteochrondrosarcomas were found in the 1.0 μCi/gm level animals. The karyotype of these tumors indicated that they were all hyperdiploid. Myeloproliferative disorders, including six cases of myelogenous leukemia, were noted in a large percent of both the control and treated animals. The onset of this disorder was earlier in the treated animals. (auth)

20642 (LF-44, pp 227-36) EFFECTS OF INHALED ^{90}Y FUSED CLAY ON PULMONARY FUNCTION AND RELATED PARAMETERS OF THE BEAGLE DOG. Mauderly, J. L.; Pickrell, J. A.; Hobbs, C. H.; Benjamin, S. A.; Jones, R. K.; Barnes, J. E. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

To better describe the pathogenesis of pulmonary damage resulting from the inhalation of beta-emitting radionuclides, 13 Beagle dogs were exposed to ^{90}Y in fused clay and examined by serial pulmonary function, clinical, and related measurements. Pulmonary function testing included measurements of ventilation, lung mechanics, gas exchange, and parameters obtained under the stress of treadmill exercise and added external deadspace. Functional changes observed following exposure were correlated with pathological information obtained from dogs in the ^{90}Y toxicity studies that died at similar times post-exposure as a result of higher doses. Both treadmill and deadspace testing detected functional impairments before they became evident by clinical or radiographic examinations. Early functional defects included a non-uniform distribution of ventilation and difficulty in the alveolar-arterial exchange of oxygen. Later, tissue alterations resulted in a significantly increased energy cost of breathing. Prior to death, a major disturbance in the pulmonary circulation and in the matching of blood and inspired gas became evident. Dogs receiving an initial lung burden of 400 μCi/kg demonstrated an early, transient subclinical functional impairment that subsequently resolved or failed to progress. (auth)

20643 (LF-44, pp 272-8) EFFECT OF INHALED ^{90}Y IN FUSED CLAY ON PULMONARY CLEARANCE OF STAPHYLOCOCCUS AUREUS IN MICE. Lundgren, D. L.; Hahn, F. F.; Sanchez, A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The effect of various initial lung burdens (ILB) of ^{90}Y in fused clay on the clearance of inhaled Staphylococcus aureus from the lungs of mice was investigated to provide an improved understanding of the influence of localized irradiation from inhaled radionuclides on infectious processes. A significant suppression of bacterial clearance was observed in mice with ILB of 20 μCi ^{90}Y, or greater, at two, three, and four weeks post-exposure to ^{90}Y. Mice with ILB of 7.0 to 12 μCi ^{90}Y cleared inhaled bacteria from their lungs at a rate similar to control mice at two and three weeks post-exposure but bacterial clearance was suppressed slightly at four weeks. ILB's of 2.5 to 4.0 μCi ^{90}Y had no effect on clearance of inhaled bacteria. 1 μCi ^{90}Y ILB was estimated to result in 400 rads to the lung. The suppression of bacterial clearance from the lungs of mice that had inhaled ^{90}Y was most likely due to a combination of effects: direct injury to mature alveolar macrophages; injury to the alveolar macrophage precursor cells; and indirect effect on alveolar macrophage function resulting from general stress in mice. (auth)

20644 (LF-44, pp 279-82) HISTOPATHOLOGICAL CHANGES IN MICE THAT INHALED $^{144}CeO_2$ AND SUBSEQUENTLY INFECTED WITH INFLUENZA VIRUS. Lundgren, D. L.; Chiffelle, T. L.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The influence of influenza virus infection on radiation-induced pulmonary changes produced by inhaled $^{144}CeO_2$ in mice was investigated. Animals that inhaled $^{144}CeO_2$ had moderate to substantial histopathological changes ranging from radiation pneumonitis to atypical hyperplasia of the bronchiolar epithelium. In mice that inhaled $^{144}CeO_2$ and subsequently were inoculated with influenza virus at 8, 12, or 20 weeks post-inhalation, histopathological changes were more pronounced. The most significant changes were in the mice infected with virus at 20 weeks post-exposure in which squamous cell differentiation was a prominent finding, progressing in one case to a superficial resemblance to epidermoid carcinoma. (auth)

20645 (LF-44, pp 283-6) CHROMOSOME ABERRATIONS IN CULTURED LYMPHOCYTES OF THE BEAGLE DOG FOLLOWING INHALATION OF ^{90}Y OR ACUTE EXPOSURE TO ^{60}Co IN VIVO OR IN VITRO. Hewitt, C. H. Jr.; Brooks, A. L.; Jones, R. K. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

A dose response relationship for chromosome aberrations in Beagle dog lymphocytes was defined following acute ^{60}Co γ exposure in vivo and in vitro and after inhalation of ^{90}Y in fused clay particles. The chromosome aberration frequency was the same for the lymphocytes exposed to ^{60}Co γ in vitro and in vivo. The inhalation exposures of the dogs to ^{90}Y resulted in initial lung burdens of 0, 1, 4, and 8 mCi. At one, seven, and 28 days post-inhalation, significant increases in the frequency of rings plus dicentrics were observed at the highest activity level exposed over the two longest time intervals. The frequency of rings plus dicentrics increased at the same rate for both the ^{60}Co γ and ^{90}Y β + γ exposures. Because of variability in the control data, there were no significant increases in aberration frequency until the dose was well above the $LD_{50/60}$ value for dogs. For this reason, the chromosomes of the peripheral blood lymphocytes of the dog do not appear to be a useful biological indicator of damage following external exposures to ^{60}Co γ or inhalation of radioactive ^{90}Y particles. (auth)

20646 (LF-44, pp 291-8) CYTOGENETIC EFFECTS OF ^{144}Ce ON THE METAPHASE CHROMOSOME OF THE CHINESE HAMSTER LIVER CELLS IN VIVO. Brooks, A. L.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Chinese hamsters were injected intraperitoneally with 0.45, 0.15, 0.05, 0.017, 0.006, 0.002 and 0.0 μCi of $^{144}Ce-^{144}Pr$/gm body weight and partially-hepatectomized at four, 13, 40, 120, 360, or 720 days post-injection. At 50 hours post-surgery, the animals were injected with colchicine and sacrificed four hours later to measure the aberration frequency in the metaphase chromosomes. The frequency of chromosome aberrations increased linearly through 362 days with an aberration coefficient of 3.1×10^{-4} aberrations/cell/rad. For doses up to 17,000 rads through 362 days of the study, there were no signs of saturation or plateauing of the radiation dose effect curve. At 722 days post-injection, the slope of the dose response curve had decreased to 1.8×10^{-4} aberrations/cell/rad and the aberration frequency in the controls had more than tripled. Changing dose rate over a range of 2 to 250 rads/day had no effect on the frequency of aberrations/cell/rad. The efficiency of producing aberrations per rad of dose was equal to that observed after protracted ^{60}Co γ exposure. The dose required to produce a level of chromosome damage higher than two standard deviations of the control data over the first 362 days was 130 rads. (auth)

20647 (LF-44, pp 299-304) RETENTION, DISTRIBUTION, DOSE, AND CYTOGENETIC EFFECTS OF ^{241}Am CITRATE IN THE CHINESE HAMSTER. McKay, L. R.; Brooks, A. L.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Chinese hamsters, injected intraperitoneally with 3.3×10^{-2} or 1×10^{-3} μCi ^{241}Am citrate/gm body weight, were sacrificed at 1, 2, 4, 8, 16, 32, 64, 225, and 360 days post-injection to determine the tissue distribution and to calculate the radiation dose to the liver and bone. After a rapid early clearance, the whole-body retention of the ^{241}Am decreased with an effective half-life of approximately 1,000 days. The liver and skeleton contained 50% and 22% respectively, of the initial body burden at 360 days post-injection. Autoradiographic studies indicated that the isotope was randomly distributed in the liver parenchymal cells. Bone activity was deposited preferentially on bone surfaces while thyroid radiographs showed no evidence of ^{241}Am accumulation by 32 days post-injection. Additional animals were injected with 1×10^{-1}, 3×10^{-2},

1×10^{-2}, and 5×10^{-3} μCi ^{241}Am citrate/gm body weight with mean survival times of 36, 91, 138, and 342 days, respectively. The most frequent pathologic alterations noted were bone marrow hypoplasia and biliary and nodular hyperplasia in the liver. For cytogenetic evaluation, hamsters were injected with graded levels of activity from 5×10^{-3} to 6×10^{-7} Ci ^{241}Am citrate/gm body weight and sacrificed at 6, 15, 42, 122, and 362 days post-injection to determine the frequency of metaphase chromosome aberrations in the liver. Partial-hepatectomy was used to stimulate hepatic cell division and colchicine was administered to accumulate cells in metaphase. The frequency of aberrations per cell in the liver increased linearly with cumulative radiation dose with an aberration coefficient of 7.2×10^{-3} aberrations/cell/rad. There was no change in the effectiveness of the dose per rad for producing aberrations over a dose rate range of 0.05 to 10 rads/day. ^{241}Am was about 20 times more efficient per rad in producing chromosome aberrations than protracted ^{144}Ce–^{144}Pr beta exposures. (auth)

20648 (LF-44, pp 305-10) IN VIVO CYTOGENETIC EFFECTS OF ^{252}Cf ON LIVER AND BONE MARROW OF THE CHINESE HAMSTER. Brooks, A. L.; Mewhinney, J. A.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The various types of radiation emitted by ^{252}Cf complicate the calculation of its effectiveness in producing biological abnormalities. As one approach to this problem, effectiveness was measured by determining the frequency of chromosomal alterations in Chinese hamster liver and bone marrow cells. Hamsters were intraperitoneally injected with graded activities of ^{252}Cf citrate at pH 6.0 (4.5×10^{-2}, 1.5×10^{-2}, 5.0×10^{-3}, 1.7×10^{-3} and 5.6×10^{-4} μCi/gm body weight), and sacrificed at 6, 15, and 42 days post-injection. Fifty-four hours before sacrifice, the animals were partially-hepatectomized to stimulate liver cell division, and 50 hours later they were injected with colchicine to accumulate metaphase liver and bone marrow cells. The frequency of aberrations in the bone marrow was very low at all times and activity levels. When the animals injected with the three highest levels of ^{252}Cf were considered collectively, the aberration frequency was four times that of the control animals. There was a linear increase in the total aberration frequency in liver cells with increasing dose through all the time intervals studied. The coefficient of 3.3×10^{-3} aberrations/cell/rad was approximately half the 7.2×10^{-3} aberrations/cell/rad seen following exposure to ^{241}Am, a pure alpha emitting radionuclide. When only the dose from the alpha emissions of the ^{252}Cf was considered, the aberration coefficient (6.3×10^{-3} aberrations/cell/rad) was not significantly different from that for ^{241}Am. (auth)

Nuclide Kinetics and Toxicology

Refer also to abstract 20623.

Man

Refer also to abstract 20317.

20649 (CONF-700909–, pp 566-94) CONTROL OF FALLOUT CONTAMINATION IN THE POSTATTACK DIET. Thompson, J. C. Jr.; Wentworth, R. A.; Comar, C. L. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Radioactive fallout from nuclear weapons testing has resulted in widespread research efforts designed to define pathways, establish deposition and uptake models, and develop predictive capabilities for radionuclide levels and their associated hazards. Within this broad research effort are methods that offer promise for reducing dietary radionuclide intake levels. The various alternatives considered for the radionuclides of primary importance (^{131}I, ^{90}Sr, and ^{137}Cs) are discussed. Much of the actual direction and use of such procedures would depend on the severity of the nuclear attack since many other problems (health, nutrition, etc.) could easily require more-immediate control than those of radionuclide intake. Maximum use of available procedures might occur in releases from a single, isolated event where maximum recovery forces were operating. In contrast, mass nuclear attacks would reduce the immediate priority for controlling radionuclide intake levels, and only the most effective methods might be considered feasible. Under a widespread attack there would be a need for additional guidelines that respond to tolerance or survival levels of radioactivity rather than to the minimum-exposure concept, as all current guidelines do. (auth)

Animals

Refer also to abstracts 20578, 20638, 20639, and 20647.

20650 (CONF-700909–, pp 259-68) RADIOIODINE AIR UPTAKE IN DAIRY COWS AFTER A NUCLEAR-CRATERING EXPERIMENT. Engel, Ronald E.; Randecker, Victor W.; Barth, Delbert S. (Bureau of Air Pollution Sciences, Research Triangle Park, N. C.); Black, Stuart C. (Western Environmental Research Lab., Las Vegas, Nev.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

During a nuclear-cratering experiment, four lactating and three dry, pregnant dairy cows were exposed to the effluent cloud in an experiment designed to measure the transfer of radioiodine to milk, tissues, and excreta of the dairy cow when exposure was due primarily to inhalation during cloud passage. The lactating cows were milked twice daily. The dry cows were sacrificed at three different times after the event. Radioiodine was measured in all milk samples and in 50 different biological samples from each of the sacrificed animals. The "inhalation" exposure as calculated from air-sampler data was not sufficient to account for the observed milk levels; this indicated that the majority of the exposure occurred by inadvertent ingestion. The term "air uptake" was used to take into consideration all routes of entry. At 56 hr postevent the ^{131}I concentration was higher in the abomasal tissue than any other tissue except the thyroid and higher in abomasal contents than in the contents of the remainder of the gastrointestinal tract. The effective time in abomasal tissue and contents was also longer than in other samples, except in the thyroid. In maternal and fetal thyroids, the peak concentration occurred at 72 hr postexposure, when the thyroids contained 5.3 and 4.5%, respectively, of the estimated intake. However, the concentration in fetal thyroid was 2.4 times that of the maternal thyroid. (auth)

20651 (LF-44, pp 51-9) APPLICATION OF DISSOLUTION THEORY TO DEPOSITION AND RETENTION OF INHALED PARTICLES. Thomas, R. G. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The quantity of toxic material deposited in the lung and its retention pattern determine the insult received by the lung from the inhaled material. Recognizing the potential importance of particle dissolution in determining the clearance of particles from the lung, certain parameters that may influence the toxicity of inhaled particles have been determined using Mercer's dissolution theory and assuming that deposited particles in the lung following inhalation are log-normally distributed and that clearance of these particles is solely by dissolution. These parameters include the median size and spread of the aerosol deposited in the deep lung, and the gross retention pattern for polydisperse fused clay aerosols. Results are reported from studies on the distribution of ^{137}Cs fused clay aerosols following a 10 min inhalation exposure of dogs and rats and the distribution of a water suspension of the aerosol particles following intravenous injection into rats. (C.H.)

20652 (LF-44, pp 60-5) PRELIMINARY STUDIES OF THE PULMONARY RETENTION OF INHALED $^{133}BaCl_2$, $^{133}BaSO_4$, AND ^{133}Ba-FUSED CLAY AEROSOLS. Cuddihy, R. G.; Hall, R. P. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The chemical form and solubility of radioactive aerosols are known to have a marked influence on lung retention of deposited activity. To provide an improved understanding of the relationship between in vitro solubility and lung retention, the lung retention of ^{133}Ba was observed in Beagle dogs following inhalation of $^{133}BaCl_2$, $^{133}BaSO_4$, heat treated $^{133}BaSO_4$ and ^{133}Ba in fused montmorillonite clay for comparison with in vitro solubility determinations. All aerosols when deposited in lung showed an initial soluble fraction of ^{133}Ba that was rapidly absorbed into the general circulation and a second less soluble fraction remaining in lung with a half-time of 20-40 days for chloride and sulfate chemical forms and 450 days for ^{133}Ba in fused clay. In vitro dissolution rates of samples of the various aerosols were also measured and preliminary comparisons were made with the observed pulmonary clearance rates. Reasonable, qualitative similarities between these data were observed. (auth)

20653 (LF-44, pp 66-9) IN VIVO SOLUBILITY OF FOUR DIFFERENT FORMS OF ^{133}Ba FOLLOWING INTRAMUSCULAR INJECTION INTO RATS. Thomas, R. G.; Ewing, W. G.; Catron, Diane L.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The in vivo solubility of particles deposited in the lung is a major determinant of their rate of removal and translocation to other tissues. To assess the in vivo solubility of selected radiobarium compounds, albino rats were given intramuscular injections of four ^{133}Ba labeled Ba compounds, fused clay, chloride, sulfate, and carbonate. The fraction of the administered activity retained at the site of injection and in whole body was periodically assessed. The chloride and carbonate forms left the injection site rapidly with significant translocation to other tissues attesting to the high degree of solubility of these forms. The sulfate form was more insoluble leaving the injection site with a half-life of 25 to 30 days with significant translocation to other tissues. The constant of specific solubility for $BaSO_4$ was estimated to be about 6×10^{-7} gm/cm^2/day. The ^{133}Ba labeled fused clay was tenaciously retained at the site of injection such that it was not possible to obtain an accurate estimate of the retention half-time over the 100-day observation period. However, the data obtained to date approximate the 900-day retention half-time observed for intravenously administered ^{137}Cs labeled fused clay for which a specific solubility constant of 2.5×10^{-8} gm/cm^2/day was calculated. (auth)

20654 (LF-44, pp 70-5) PRELIMINARY STUDY OF RETENTION KINETICS AND DISTRIBUTION OF ^{60}Co OXIDE AEROSOLS IN THE BEAGLE. Barnes, J. E.; Kanapilly, G. M.; Newton, G. J. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The retention and distribution of two different ^{60}Co oxides following inhalation were studied in dogs to assess the potential inhalation hazard. Cobaltosic oxide (Co_3O_4) was formed by passing a cobalt nitrate aerosol through a heating column at 850°C before delivery to the dog. Cobaltous oxide (CoO) was formed by raising the heating column temperature to 1400°C. Three Beagle dogs were exposed to $^{60}Co_3O_4$ and sacrificed singly at 8, 64, and 128 days. Three Beagle dogs were exposed to ^{60}CoO and sacrificed at 8, 16, and 64 days post-exposure. Whole-body retention patterns showed that ^{60}CoO left the body with a shorter effective half-life than $^{60}Co_3O_4$. The concentration of ^{60}Co detected in the blood was at least an order of magnitude higher in the dogs exposed to ^{60}CoO than in the dogs exposed to $^{60}Co_3O_4$, and ^{60}Co translocated from the lung accumulated predominantly in the kidney, liver, skeleton, and cartilagenous structures such as the trachea. Higher concentrations were reached earlier in the dogs exposed to ^{60}CoO. After early fecal excretion of material deposited in the upper respiratory tract, excretion was greatest via the urine. The higher solubility of the ^{60}CoO formed at 1400°C relative to $^{60}Co_3O_4$ formed at 850°C was unexpected considering that generally aerosols formed at higher temperatures are more insoluble than aerosols formed at lower temperatures. (auth)

20655 (LF-44, pp 76-80) INTRAORGAN DISTRIBUTION IN THE BEAGLE DOG OF ^{91}Y INHALED AS THE OXIDE, PHOSPHATE, AND IN FUSED CLAY. Newton, G. J.; Hobbs, C. H.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Yttrium-91, a major fission product, has a potential for accidental release in a variety of forms. To evaluate the importance of chemical form on the toxicity of ^{91}Y, the distribution of ^{91}Y following inhalation of aerosols of $^{91}Y_2O_3$, $^{91}YPO_4$ and ^{91}Y in fused clay was investigated in Beagle dogs. Six Beagle dogs were exposed to each of the forms and sacrificed three each at 8 and 64 days post-inhalation exposure. Selected tissues were analyzed for ^{91}Y content by radiochemical techniques and proportional beta counting. In the three forms studied ^{91}Y was retained in the body with approximately a 50 day biological half life. The ^{91}Y in the fused clay was avidly retained in the lungs with only traces translocated to liver and skeleton, while ^{91}Y in the oxide and phosphate forms was less avidly retained in lung with greater amounts translocated to liver and skeleton. Gavage studies were performed using aqueous suspensions of particles to determine the uptake via the gastrointestinal tract for ^{91}Y in both oxide and phosphate forms. Less than 1% of the ^{91}Y was absorbed by the gastrointestinal tract. (auth)

20656 (LF-44, pp 81-5) DISTRIBUTION AND EXCRETION IN THE BEAGLE DOG OF ^{106}Ru-Rh AEROSOLS SUBJECTED TO THERMAL DEGRADATION. Newton, G. J.; Latven, R. K. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

An investigation of the distribution and excretion of three forms of radio-ruthenium compounds in Beagle dogs is described. Aerosols of ^{106}Ru-Rh ruthenium oxalate were generated and treated at 100°, 500° and 1000°C. Two dogs were exposed to each of the different temperature treated aerosols: one via a single inhalation exposure and one via gavage. Even in complexed forms (100°C treatment) ruthenium is retained in the lungs; however, if the ruthenium complex is subjected to thermal degradation (500°C and 1000°C) the lung retention is increased by a factor of 5 to 6. Significant amounts (20%) of ruthenium oxalate (100°C treatment) were absorbed by the gastrointestinal tract but less than 1% was absorbed when the material had been heat treated at 500° or 1000°C. (auth)

20657 (LF-44, pp 86-9) INFLUENCE OF CARRIER CERIUM ON RETENTION AND TISSUE DISTRIBUTION OF INJECTED ^{144}Ce IN THE RAT. Thomas, Randi L.; Scott, R. T.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Recognizing that accidental exposures may involve material of varied specific activity, a study has been conducted to evaluate the influence of carrier $CeCl_3$ or CsCl on the retention and distribution of injected ^{144}Ce. This study, a prelude to a study utilizing inhalation exposures, included 36 rats given either intramuscular, intraperitoneal, or intravenous injections of $^{144}CeCl_3$ with 5.0×10^{-3} mg CsCl/ml; 2.5×10^{-3} mg CsCl/ml and 2.5×10^{-3} mg $CeCl_3$/ml; or 5.0×10^{-3} mg $CeCl_3$/ml. Half of the rats were sacrificed two hours after injection and dissected. The other half were periodically whole-body counted and their excreta collected for 16 days post-injection, after which they were sacrificed and dissected. In general, with the highest Ce concentration, whole-body retention of ^{144}Ce was greatest. In the intramuscularly injected rats, most of the ^{144}Ce was retained at the injection site with the greatest translocation occurring with the least carrier Ce. With intravenous injection, ^{144}Ce liver content increased and ^{144}Ce carcass content decreased with increased carrier Ce. An opposite, but less marked effect, was seen with intraperitoneal injection of ^{144}Ce. (auth)

20658 (LF-44, pp 90-5) RETENTION AND TISSUE DISTRIBUTION OF ^{144}Ce FOLLOWING INHALATION OF $^{144}CeO_2$ IN SYRIAN HAMSTERS. PRELIMINARY OBSERVATIONS. Thomas, Randi L.; McClellan, R. O.; Henderson, Rogene F.; Pfleger, R. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Sixty Syrian hamsters were exposed to an aerosol of $^{144}CeO_2$ (activity median aerodynamic diameter of 0.77 μm and geometric standard deviation of 1.3) to assess basic characteristics of initial deposition, clearance, and tissue distribution of a relatively insoluble material in this species which is being used in increasing numbers in inhalation toxicity studies. About 70% of the initial body burden was excreted within one week post-inhalation exposure, with fecal exceeding urinary excretion by a factor of about 10. Little translocation from lung to other organs was noted through 128 days post-exposure, with approximately 2% of the retained ^{144}Ce found in the liver and none detectable in the skeleton at that time. The rate of decrease in whole-body burden lessened with time post-inhalation exposure; near the end of the four-month observation period the biological half-time of retention was in excess of 200 days. (auth)

20659 (LF-44, pp 96-101) RETENTION AND DISTRIBUTION OF INJECTED ^{252}Cf IN RATS AND CHINESE HAMSTERS. Mewhinney, J. A.; Brooks, A. L.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Increased production and use of ^{252}Cf has indicated the need for additional research on the metabolism of this element in experimental animals with a view toward providing a basis for predicting its metabolism in man. As a prelude to inhalation studies, the retention of ^{252}Cf in rats and Chinese hamsters was observed for 64 days following intraperitoneal injection of a citrate complex of ^{252}Cf. Organ distribution was determined by serial sacrifice of groups of six animals at 1, 2, 4, 8, 16, 32, and 64 days post-injection for each species. Comparison of the whole-body retention pattern of ^{252}Cf in the rat and Chinese hamster revealed significant differences. Although whole-body clearance was nearly equal at comparable times post-injection through 64 days, differences were reflected in the number of exponential components needed to adequately describe the data and in the effective half-times of the long-term components of the two equations. For rats the long-term component was clearly a function of avid skeletal retention whereas the long-term component for Chinese hamster retention was a function of combined liver and skeletal retention. The greater contrasts between the two species were noted in organ distribution and retention. The rat initially deposited much lower quantities in the liver and kidney. Elimination from these organs was characterized by half-times of approximately five days. In the Chinese hamster, initial deposition in the kidney and liver was

greater than in the rat. The hamster kidney deposition was eliminated much like the rat with a short effective half-time. However, the liver of the hamster retained the initial burden much longer than did the rat liver. (auth)

20660 (LF-44, pp 102-6) COMPARATIVE BEHAVIOR OF INHALED ^{239}Pu, ^{241}Am, AND ^{244}Cm IN BEAGLE DOGS. McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The comparative tissue distribution of inhaled ^{239}Pu, ^{241}Am, and ^{244}Cm aerosols in Beagle dogs was reviewed. A similar pattern of relatively rapid clearance from lung with translocation to liver and skeleton was noted for $^{244}CmO_{1.73}$, $^{244}CmCl_3$, and $^{241}AmO_2$. In contrast, ^{239}Pu oxide, fluoride, and nitrate were much more avidly retained in the lung. The rate of loss of the actinides from lung was reflected in the early urinary excretion rate which was about two orders of magnitude higher for ^{241}Am and ^{244}Cm than for $^{239}PuO_2$ with the urinary excretion of ^{239}Pu fluoride and nitrate being intermediate. Related to the rapid decrease in lung content of ^{241}Am and ^{244}Cm was a rapid increase and avid retention of these elements in liver and skeleton. $^{239}Pu(NO_3)_4$ was also translocated to liver and skeleton although to a slightly lesser extent. At early time periods $^{239}PuO_2$ leaving lung was primarily translocated to tracheobronchial lymph nodes. These differences in the behavior of three adjacent actinide elements must be considered in assessing their potential hazard, in interpreting bioassay results, and in the establishment of radiation protection guides. (auth)

20661 (LF-44, pp 107-9) LEAST SQUARES FITTING FOR FLOW CONSTANTS IN FIRST ORDER LINEAR RETENTION MODELS. Hulbert, A. J. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

A mathematical model of the redistribution of radionuclides from the site of initial deposition is important in studies of biological effects of radiation. A first order linear retention model developed for this purpose is described mathematically. The nonlinear optimization problem is defined, after which the solving for flow constants is formulated as a special case of non-linear optimization. Preliminary results obtained using computer calculations are briefly discussed. (C.H.)

20662 (LF-44, pp 114-20) RELATIVE NONHOMOGENEITIES OF RADIATION DOSE TO THE RESPIRATORY TRACT FROM INHALED RADIONUCLIDES. Barnes, J. E.; Hulbert, A. J.; Osborn, L. A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Knowledge of the distribution of inhaled radionuclides along the respiratory tract is essential to evaluating the resultant radiation dose and potential biological effects. To obtain such information, Beagle dogs were exposed to radioactive aerosol, sacrificed, frozen and sectioned. Autoradiographs of transverse thoracic sections were analyzed with a scanning microdensitometer. Computer techniques were used to yield isodose contour mappings of the radiation dose distribution. The homogeneity of the lung dose from inhaled ^{90}Sr fused clay in dogs sacrificed at 4 and 80 days is described. Additional studies of a nonhomogeneous accumulation of inhaled radionuclides in a striated pattern near the costal surface of the lung are also reported. This striated pattern has been observed autoradiographically in dogs exposed to aerosols and sacrificed as long as 768 days post-exposure and immediately post-exposure in one monkey. The striations were observed to a depth of 9.5 mm from the pleural surface. A similar striated pattern of carbon deposits has been reported in man at autopsy. (auth)

20663 (LF-44, pp 151-63) TOXICITY OF INHALED ^{91}Y FUSED CLAY IN BEAGLE DOGS. II. Hobbs, C. H.; Cuddihy, R. G.; Hahn, F. F.; Jones, R. K.; Kanapilly, G. M.; Mauderly, J. L.; McClellan, R. O.; Pickrell, J. A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Studies of the radiological hazards due to inhalation of ^{91}Y in fused clay aerosols are being conducted in Beagle dogs to aid in assessing the biological consequences of inhaling a relatively insoluble, high energy β emitter with a short to intermediate effective half-life in the lung. These consist of two parallel efforts: a radiation dose pattern study in which 30 dogs were exposed to ^{91}Y entrapped in fused clay and were serially sacrificed from 0 to 320 days post-exposure; and a longevity study in which 96 dogs have been exposed to ^{91}Y entrapped in fused clay with initial lung burdens ranging from 11 to 360 $\mu Ci^{91}Y/kg$ of body weight and 12 control dogs exposed to stable yttrium in fused clay. The aerosols ranged in size from 1.5 to 2.6 μm AMAD. Total body deposition of ^{91}Y ranged between 40 and 50% of the inhaled activity with about 22% deposited in the pulmonary region of the lung. The ^{91}Y deposited in the pulmonary region was retained in the lung with a mean effective half life of 50 days whereas the whole-body effective half life was found to be 53 days. Small quantities of ^{91}Y were translocated to the tracheobronchial lymph nodes, liver, and skeleton. Concentrations of ^{91}Y in tracheobronchial lymph nodes exceeded that of the lung by 50 days post-exposure. Fecal excretion of ^{91}Y exceeded urinary excretion and was the major pathway for elimination from the body at all times during the experiment. In the longevity study 26 dogs have died, to date, between 113 and 295 days post-exposure. The cumulative radiation dose to lung at death ranged from 14,000 to 47,000 rads. The surviving dogs with the highest initial lung burdens are presently showing clinical signs typically associated with radiation-induced pulmonary injury. Principal clinical and pathological findings in the dogs that died have been related to pulmonary edema, inflammation, fibrosis and vascular obliterative changes. At this time it appears that only dogs with potential cumulative infinite radiation dose to lung of less than 15,000 to 16,000 rads will be long-term survivors. All survivors will be observed over their lifespan with particular attention directed toward relating ^{91}Y tissue radiation dose distributions and the resulting clinicopathological effects. (auth)

20664 (LF-44, pp 164-80) TOXICITY OF INHALED ^{144}Ce FUSED CLAY IN BEAGLE DOGS. IV. Boecker, B. B.; Hahn, F. F.; Hobbs, C. H.; Jones, R. K.; Mauderly, J. L.; McClellan, R. O.; Pickrell, J. A.; Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The metabolism, dosimetry, and effects of inhaled ^{144}Ce in fused clay aerosols are being investigated in the Beagle dog to aid in assessing the biological consequences of release of ^{144}Ce in a relatively insoluble form such as might occur in certain types of nuclear accidents. Further, the toxicity of inhaled ^{144}Ce fused clay is of broad interest since it may be considered as representative of a group of intermediate-lived beta emitting radionuclides. Two major studies are being performed: a metabolism and dosimetry study in which 24 dogs have been serially sacrificed over an extended period of time; and a longevity study with two series of dogs exposed to aerosols of ^{144}Ce in fused clay to yield initial lung burdens of 88 to 2100 μCi or of 0.02 to 570 μCi. The ^{144}Ce in fused clay is slowly translocated from the lung to tracheobronchial lymph nodes, liver, and skeleton, however, because of the small size of the tracheobronchial lymph nodes they exceed the lung in ^{144}Ce concentration by 100 days post-inhalation. At 768 days post-inhalation exposure, 45% of the retained activity is in lung, 30% in liver, 17% in skeleton, and 4.7% in tracheobronchial lymph nodes. To date, 18 dogs have died or been euthanized at 143 to 1318 days after inhalation of ^{144}Ce. The prominent findings have been pulmonary fibrosis and four cases of hemangiosarcoma of the lung. The cumulative radiation dose to the lung to time of death has ranged from 19,000 to 110,000 rads. The 108 surviving dogs include dogs with a potential for accumulating radiation exposures to lung of up to 43,000 rads. Serial observations are continuing on all survivors with special attention directed toward evaluating ^{144}Ce metabolism and dosimetry, and various clinical, pulmonary function, hematologic, serum chemical, and microbiologic parameters. (auth)

20665 (LF-44, pp 319-22) CLINICAL AND EXPERIMENTAL USES OF BRONCHOPULMONARY LAVAGE: A REVIEW. Muggenburg, B. A.; Jones, R. K. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Bronchopulmonary lavage, a procedure for washing out the lungs, has been used in the treatment of human patients with chronic obstructive lung disease and more recently has been evaluated as a means for removing inhaled radioactive particles from the lung. The procedure was performed 215 times in 146 dogs with five complications which resulted in death. A review of the literature revealed that 72 human patients with serious intrinsic pulmonary disease have been treated by this procedure, and only one death has occurred. (auth)

20666 RESEARCH ON THE FIXATION OF ^{32}P AND ^{45}Ca IN THE SKELETAL SYSTEM OF ANIMALS. Capone, W.; Contu, M.; Mascia, C.; Melis, M. (Univ., Cagliari, Italy). Minerva Fisiconucl.; 15: No. 2, 81-6 (Apr-Jun 1971). (In Italian).

The values obtained during and after the administration of ^{32}P to chickens reveal uptake values analogous to those of cold phosphorus. This behavior is attributed to the high metabolism of phosphorus and to the very brief half-life of ^{32}P. The results

obtained with ^{45}Ca indicate a certain tendency to form radioactive zones in the distal part of the skeleton. Two factors which can lead to toxicity are a rather long decay period and a slower metabolism rate than that of phosphorus. The formation of radioactive zones in the distal parts of the skeletal system observed in studies with ^{90}Sr and ^{45}Ca can be attributed not only to the presence of ^{90}Sr in the bone tissue but also to the uptake of ^{45}Ca. (J.S.R.)

20667 EFFECT OF SOME SYMPATHOMIMETIC AMINES ON THE TISSUE CLEARANCE OF RADIOSODIUM INJECTED INTO THE HIND LEG OF THE RAT. Astroem, A.; Persson, N. H. (Karolinska Institutet, Stockholm). Acta Pharm. Toxicol.; 30: No. 1-2, 29-35(1971).

The effect of some sympathomimetic amines on the rate of disappearance of ^{22}Na injected into the hind legs of rats was studied. The technique used was developed particularly for studying the influence of new drugs on capillary blood flow, i.e., the factor primarily determining drug absorption. Decreased capillary circulation (sodium clearance) in the muscle pocket of the sciatic nerve was produced, in order of efficacy, by adrenaline, noradrenaline, levonordefrin, phenylephrine and metaraminol, in concentrations of 10 and 100 μg/ml. Isoprenaline in low concentration (0.01 μg/ml) was found to enhance capillary circulation. (auth)

Plants

20668 (CONF-700909-, pp 396-404) FIELD STUDIES OF FALLOUT RETENTION BY PLANTS. Witherspoon, John P. (Oak Ridge National Lab., Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Several field studies on the retention by plants of local fallout particles (particles exceeding 44 μ in diameter) are summarized. Although initial fractions of fallout intercepted varied as a function of plant-foliage characteristics and particle size, average initial retention values are similar for studies done with a wide variety of plants in different geographical regions. Rapid losses of particles from foliage and other plant parts due to weathering occurred generally during the first week following initial particle deposition. Losses from tree species during this period were several times greater than losses from crop plants. In a period of 1 to 2 weeks following deposition all plants lost 90% or more of the fallout particles initially intercepted. After about 3 weeks the loss of particles was relatively constant and proceeded at a slow rate (average weathering half-life of 21.3 ± 3.9 days) regardless of subsequent rain and wind conditions. (auth)

20669 (CONF-700909-, pp 405-18) RETENTION OF NEAR-IN FALLOUT BY CROPS. Lovaas, A. I.; Johnson, J. E. (Colorado State Univ., Fort Collins). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Near-in fallout simulant, 88- to 175- to 350-μ sand labeled with ^{177}Lu, was dispersed over field crops. Initial retention and weathering half-time were measured for alfalfa, corn, barley, bromegrass, sudan grass, and sugar-beet tops. (auth)

20670 (CONF-700909-, pp 492-508) PREDICTION OF RADIONUCLIDE CONTAMINATION OF GRASS FROM FALLOUT-PARTICLE RETENTION AND BEHAVIOR. Dahlman, Roger C. (Oak Ridge National Lab., Tenn.). Dec 1971.

From Symposium on survival of food crops and livestock in the event of nuclear war; Upton, N. Y. (15 Sep 1970).

Retention of large (44- to 188-μ) fallout-simulant particles by dense fescue grass approached 50% initially, but, from 1 hr to 1 day later, weathering processes decreased retention to 10%. A modified negative-exponential function characterized particle weathering over a 2- to 3-week period. Half-time for early weathering loss was 3 to 4 days, but retention approached an asymptotic level after 2 to 3 weeks, at which time 2% of the ground-surface deposit remained on vegetation. Particle deposits on leaf blades were readily removed by slight wind (<1 mph) and phytotaxic movements of the foliage. Axillary deposits, however, were not readily removed by wind and rain. Using Miller's contamination factor convention ($a_L = C_p/m$) and nuclide leachability, we predicted the ^{137}Cs contamination of fescue foliage (F_L) from fallout simulant independently according to the expression $F_L = a_L W_L$. (auth)

20671 EFFECT OF SPECIES SPECIFICITY ON THE ^{90}Sr UPTAKE BY PLANTS FROM THE SOIL. Korneeva, N. V. Dokl. Vses. Akad. Sel'skokhoz. Nauk; No. 1, 5-7(1970). (In Russian).

A five-year program of experimentation with spring wheat was conducted with 20 species and varieties of Triticum. Results showed that various varieties of spring wheat differed in their assimilation tendency toward ^{90}Sr, stable Sr, and Ca. An unequal uptake of ^{90}Sr per unit of Ca was noted. The possibility of selecting wheat varieties which have the smallest tendency to remove ^{90}Sr from the soil, both on the basis of dry weight and on the basis of the Sr/Ca ratio is discussed. (tr-auth)

New Tracer Techniques

Refer also to abstract 20623.

20672 RADIATION BIOLOGICAL TECHNIQUES IN THE STUDY OF THYROID FUNCTION. Srivastava, P. N. (Rajasthan Univ., Jaipur, India). Bull. Nat. Inst. Sci. India; No. 36, 82-8 (1968).

Various radiation biological techniques using ^{131}I (thyroid uptake, percent; urinary excretion rate; conversion ration; red blood cell uptake of ^{131}I-labelled thyronine; and thyroid secretion rate) have been described for the evaluation of thyroid function. (14 references) (Indian Sci. Abstr.)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 20147, 20155, 20159, 20187, 20248, 20249, 20771, 20777, 20781, 20826, 20827, 20861, 20878, 20887, 20945, 22087, 22114, 22119, 22121, 22122, 22125, 22127, and 22129–22132.

20673 (AD–731826) PREPARATION AND CHARACTERIZATION OF HIGH-PURITY SUBMICRON REFRACTORY OXIDES AND MIXED OXIDES FROM ALKOXIDES. Technical Report, January 1, 1967–June 30, 1971. Hoch, Michael (Cincinnati Univ., Ohio). Aug 1971. Contract F33615-67-C-1296. 141p. (AFML-TR-71-158). NTIS.

A method was developed to prepare high purity, highly uniform, very reactive, small, under 100 Å crystallite size ceramic powders. The method consists of preparing a water sensitive organometallic compound, preferably an alkoxide, and decomposing it by hydrolysis. The hydroxide is then washed using high purity water or alcohol, dried, ball milled, and finally calcined at 550C. By varying the treatment of the hydroxide, two different types of powders, A and B, were obtained. Powder A is suited for hot pressing consolidation, and powder B for cold pressing and sintering. The method was specifically developed for the large scale preparation of zirconium oxide containing 6.5 mole % yttrium oxide (Zyttrite). However, a similar process was successfully applied to other ceramic materials such as ferrites, and PLZT (lead lanthanum zirconate titanate). In conjunction with development of the production method, the properties of both type A and B Zyttrite were studied to determine which were important to its capacity for sintering. (auth) (USGRDR)

20674 (AED-CONF–71-100-28) WORK ON HIGH PERFORMANCE CERAMIC AND CERMET FUEL IN KERNFORSCHUNGSZENTRUM KARLSRUHE. Dienst, W.; Dippel, Th.; Goetzmann, O.; Hofmann, P.; Holleck, H.; Kleykamp, H.; Siebmanns, W.; Thuemmler, F.; Weimar, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). May 1971. 25p. (CONF-710901–526). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development of fuel and fuel elements for fast reactors in Germany is reviewed including status of oxide fuel activity; work on nonoxide fuel (potential of nonoxide fuels, nitride and carbide fuel preparation studies, compatibility of UN, UC, and U(C,N) with cladding materials, and phase diagram and thermodynamic studies); and cermets with high fissile ceramic loading and idealized structure (fabrication of cermets and irradiation performance of UO_2 cermets with high ceramic content). (D.H.M.)

20675 (ANL–7827) COMPATIBILITY OF URANIUM–PLUTONIUM CARBIDE FUELS AND POTENTIAL LMFBR CLADDING MATERIALS. Latimer, T. W. (Argonne National Lab., Ill.). Sep 1971. Contract W-31-109-eng-38. 42p. Dep. NTIS.

The contact compatibility (in the absence of sodium) between (U,Pu)C with equivalent carbon contents of 4.83, 5.25, and 6.75 wt % and various iron-, nickel-, and vanadium-base alloys was studied at 700 to 1100°C for 168 to 4000 h. Austenitic iron-base alloys, containing 25 wt % or less nickel and tested at 800°C for up to 4000 h, showed little or no evidence of carbon transfer from stoichiometric or hyperstoichiometric $(U_{0.8}Pu_{0.2})C$ that contained up to 20 vol % $(U,Pu)_2C_3$. Three austenitic alloys containing more than 30 wt % nickel reacted with stoichiometric and hyperstoichiometric $(U_{0.8}Pu_{0.2})C$ to form intermetallic compounds at the fuel-cladding interface and precipitates in the cladding at 700 and 800°C. Vanadium-base alloys containing 15 to 20 wt % titanium were carburized by $(U_{0.8}Pu_{0.2})C$ and reduced $(U,Pu)_2C_3$ to (U,Pu)C at 800°C. However, alloys containing 5 wt % or less titanium or other relatively strong carbide formers were only slightly affected by hyperstoichiometric (U,Pu)C at 800°C for up to 4000 h. (auth)

20676 (BARC–568) STUDIES ON SINTERING OF NUCLEAR FUEL MATERIALS: SINTERING BEHAVIOUR OF URANIA–THORIA MIXTURES. Mohan, Ashok; Moorthy, V. K. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 114p. Dep. NTIS (U. S. Sales Only).

A study of the factors affecting the sintering behavior and solid solution formation in mixtures of UO_2 and ThO_2 showed that the study would not be meaningful unless the individual powders are characterized (mainly in reference to its crystallinity) and the mechanisms of material movement is recognized. The latter depends both on the crystallinity of the material and the temperature of sintering. A concept is proposed that envisages macroscopic flow of the materials if its crystallinity is poor. In such a system addition of another constituent that does not react with it at the sintering temperature, acts as a discontinuity in the matrix, and lowers the resultant bulk density. The x-ray studies indicate that the solid solution formation starts at about 1400°C and is completed at 1550°C. 1400°C seems to be approximately the temperature around which the predominant mechanism for material transport changes from macroscopic flow to diffusion. (D.H.M.)

20677 (BMI–1919) PROGRESS ON DEVELOPMENT OF FUELS AND TECHNOLOGY FOR ADVANCED REACTORS DURING JULY–SEPTEMBER 1971. Quarterly Report. Keller, Donald L. (Battelle Columbus Labs., Ohio). Oct 1971. Contract W-7405-eng-92. 61p. Dep. NTIS.

Development of fuels and technology for advanced reactors is summarized. The programs under way are concerned with development of uranium nitride, plutonium nitride fuels for LMFBR applications, studies of fuel performance at high temperatures for LMFBR's and advanced fast reactors, and studies of creep of reactor fuel materials. Fuel pellets are being prepared for several pins. Powder was synthesized by using the hydride–nitride process on arc-cast uranium-20 wt % plutonium buttons. Pellets will be pressed, sintered, and centerless ground. The remainder of the fuel was fabricated for 20 $(U_{0.8}Pu_{0.2})N$ pins for irradiation testing in the EBR-II. Six sodium-bonded fuel pins for the BMI-5 series were loaded in accordance with accepted quality assurance procedures. In addition to the fuel-pin loadings, xenon tagging of dummy capsules was performed as required by EBR-II specifications. The xenon loading procedure was reviewed and subsequently modified to eliminate undertagging possibilities. Sodium bonding and eddy-current testing of Fuel Pins C-BMI-5-4, -5, and -6 was initiated. The eddy-current traces were difficult to analyze, so considerable effort was directed toward the determination of more optimum equipment settings, which would minimize the effect of the pellet interfaces while still permitting the detection of small voids. Interim examination of EBR-II Subassembly X-086 containing 10 BCL fuel pins was performed after a burnup of about 3 at. %. The neutron radiographs showed no unexpected or unusual behavior. The fuel pins were reconstituted into a new subassembly for further irradiation. A UO_2 specimen clad with 20-mil-thick niobium–1 wt % zirconium showed a maximum diametral swelling rate of 8 percent per 10^{20} fissions per cm^3 at a cladding surface temperature of 1435°C. A UO_2 specimen clad with 40-mil-thick tungsten showed a maximum diametral swelling rate of 0.7 percent per 10^{20} fissions per cm^3 at a cladding surface temperature of 1715°C. Samples of UO_2 and UO_2-PuO_2 containing up to 20% porosity appeared to sinter and densify early in irradiations at surface temperatures from 1260 to 1670°C. At 1260°C there was a net reduction in external dimensions. At 1390 and 1670°C there was no significant difference in the external swelling of low-density and high-density specimens. An "incubation period" for gas release from oxide fuels was observed at cladding surface temperatures ranging from 1300 to 1880°C. The length of this incubation period is a parabolic function of temperature, indicating that rate processes, such as the diffusional processes required to form and interconnect fission-gas bubbles at grain boundaries, are involved. Creep capsule BRR–Pul, which contained a UO_2-PuO_2 specimen, was assembled and successfully operated in the Battelle Research Reactor. A series of ten creep tests was run at fission rates of 0, 7×10^{12}, and 1.2×10^{13} fissions/(cm^3) (sec). All tests were run at a single stress of 2000 psi, and in the temperature range of 915 to 1125°C. The in-pile creep rates were substantially increased during irradiation with respect to the out-of-pile creep rates. In addition, the in-pile creep rate enhancement was observed to have an approximately linear dependence on fission rate. The conceptual design studies for an intermediate-temperature high-flux creep capsule were continued. Fission products were identified in in-pile irradiated creep capsules. (M.C.G.)

20678 (CEA-R–4227) SELF-DIFFUSION OF CARBON IN URANIUM MONOCARBIDE. Bertaud, Yves (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov 1971. 61p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Grenoble, France.

The self diffusion coefficients of carbon in stoichiometric uranium monocarbide were determined between 1065 and 1930°C. ^{14}C was used as a tracer, the β radioactivity being measured at the surface after annealing, either by the method of residual ac-

tivity or by the Gruzin method. The experimental results can be represented by Arrhenius' equation: $D_{(cm^2/s)} = \{7.2 \cdot 10^{-2} \exp [-(66 \text{ Kcal/mole/RT})]\}$. At low temperatures (<1300°C) autoradiographs revealed considerable grain boundary diffusion. The results obtained were compared with those previously published. (auth)

20679 (CEA-R-4244) EFFECT OF GAMMA RADIATION ON CARBON DIOXIDE–GRAPHITE AND CARBON DIOXIDE–HYDROGEN SYSTEMS. Fessler, Jean-Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Nov 1971. 74p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Grenoble Univ. (France). Faculte des Sciences.

Studies were made on the effects of the pore texture of nuclear graphite on the kinetics of radiochemical oxidation with carbon dioxide. It was concluded that the reaction rate must be considered as proportional to the gamma energy dissipated in the effective pore volume of the graphite. In macropores with radii greater than the mean free path of the active species, the effective pore volume corresponds to an envelope of gas covering the interior of the pores. In the micropores, it is effectively zero because of the high local concentrations of carbon monoxide which inhibit the reaction. The effects of gamma radiation on the hydrogen–carbon dioxide system were also studied. It was found that a stationary state is attained, both by gamma irradiation of CO_2 containing 600 vpM H_2, and by irradiation of the same mixture already at thermodynamic equilibrium. Thermodynamic considerations take into account the possibility of the evolution of a gamma irradiated chemical system at thermodynamic equilibrium. A reaction mechanism is proposed. (auth)

20680 (CONF-710612) SUMMARY OF PAPERS. Tenth Biennial Conference on Carbon, Bethlehem, Pennsylvania, June 27–July 2, 1971. (Battelle Columbus Labs., Ohio. Defense Ceramic Information Center). 362p.

Abstracts of 215 papers are included. Information is presented on surface phenomena, fibers and composites, carbon products preparation, structural studies, radiation damage, mechanical properties, carbon products applications, reactivity studies, thermal properties, and electronic properties. (P.C.H.)

20681 (CONF-710938–, pp 90) THERMAL CONDUCTIVITY OF SINGLE CRYSTAL EUROPIUM MONOXIDE. Dixon, G. S.; Martin, J. J. (Oklahoma State Univ., Stillwater. Dept. of Physics). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20682 (CONF-710938–, pp 91-2) IN-PILE THERMAL CONDUCTIVITY MEASUREMENTS ON OXIDE FUELS FOR NUCLEAR REACTORS. Calza-Bini, A.; Cosoli, G.; Filacchioni, G.; Lanchi, M.; Nobili, A.; Rocca, U.; Rotoloni, P. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20683 (CONF-710938–, pp 93-4) THERMAL DIFFUSIVITY OF THORIA–URANIA MIXED OXIDES AND SOME MATERIALS TO BE USED AS REFERENCE IN THE RANGE 650 ÷ 2,650°K. Ferro, C.; Patimo, C.; Piconi, C. (Comitato Nazionale per l'Energia Nuclear, Casaccia (Italy). Centro di Studi Nucleari). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20684 (CONF-710938–, pp 107-8) DETERMINATION OF THE HIGH-TEMPERATURE ENTHALPIES OF SOME HIGH BORON COMPOUNDS. Mar, Raymond W. (Sandia Labs., Livermore, Calif.); Stout, Norman D. (California Univ., Livermore. Lawrence Livermore Lab.). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20685 (CONF-710938–, pp 149-50) FLASH DIFFUSIVITY IN CYLINDRICAL COORDINATES. Murphy, H. D. (Los Alamos Scientific Lab., N. Mex.). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20686 (CONF-710938–, pp 153-4) THERMAL CONDUCTIVITY OF SOME UNIRRADIATED HTGR FUEL ELEMENT MATERIALS. Koyama, K. (Gulf General Atomic Co., San Diego, Calif.); Tye, R. P. 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20687 (CONF-710938–, pp 155-6) THERMAL CONDUCTIVITY OF EIGHT AEROSPACE METALS AND ALLOYS. Tye, R. P.; Hayden, R. W.; Spinney, S. C. (Dynatech R/D Co., Cambridge, Mass.). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20688 (CONF-710938–, pp 166) OBSERVATIONS ON THE THERMAL CONDUCTIVITY OF URANIUM–PLUTONIUM OXIDES. [von der] Berg, Max; [von der] Hoek, Lendaert; Richter, Joseph; Schmidt, Hans E. 1971.

From eleventh international conference on thermal conductivity, Albuquerque, N. Mex. (28 Sep 1971).

20689 (EURFNR-957) UO_2/PuO_2 STEEL CERMETS AS FUEL MATERIAL IN FUEL ELEMENTS. Foehl, C. A.; Nazare, S.; Ondracek, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report KFK-1459. 48p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 29931.

20690 (GEMP-267) REVIEW OF RECENT RESEARCH ON REFRACTORY-METAL CARBIDES AND BORIDES. Juenke, E. F. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). 11 Aug 1964. Contract AT(40-1)-2847. 24p. Dep. NTIS.

A review of the literature on the refractory-metal carbides and borides is presented. A general summary of the physical, mechanical, and thermochemical properties of the materials emphasizes references to the more recently published information. Areas requiring further extensive investigation are identified. Refractory-metal carbide and boride research being conducted at GE-NMPO is outlined, and current work by other researchers is discussed. (101 references) (auth)

20691 (GEMP-659) EVALUATIONS OF URANIUM MONONITRIDE CERMET FUEL. Collins, J. F.; Newsom, D. L. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Oct 1968. Contract AT(40-1)-2847. 21p. Dep. NTIS.

Declassified 27 Oct 1971.

As a cermet fuel uranium mononitride (UN) has been recognized to offer several advantages over other fuel forms, including higher uranium content, better thermal conductivity, and lower thermal expansion. Recent work at GE-NSP has demonstrated improved dimensional stability or resistance to growth under thermal cyclic test conditions for W–UN and Mo–UN cermet fuel cores. Stoichiometric UN of controlled particle size was prepared by direct nitriding of uranium metal shot resulting in oxygen contents of 500 to 800 ppM and particle sizes of 100 to 150 microns. W-60UN and Mo-60UN cermet compacts were prepared using this fuel and sintered in pure nitrogen at 2000°C. Clad with tungsten alloys or molybdenum, these fuel specimens were thermal cyclic tested to 1800°C in helium. After 60 rapid cycles the UN cermets grew less than 0.5 percent in diameter or about half the growth of W–UO_2 cermets tested under the same conditions. No evidence of UN instability was found. The need for further studies of UN cermets as an alternate fuel form is discussed with the objective of qualifying UN for advanced reactor and thermionic emitter applications. (auth)

20692 (KFK-EXT-6/71-2) SPECIFICATION AND PREPARATION OF UO_2–PuO_2 SAMPLE FUEL PINS WITH 4 mm DIAMETER. Vollath, D.; Depisch, F.; Dippel, Th. (Kernforschungszentrum, Karlsruhe (West Germany)). Nov 1971. 49p. (In German). Dep. NTIS (U. S. Sales Only).

Fuel pins with 4 mm fuel diameter have some advantages for a fast high flux test reactor. The specifications and production method for PuO_2-UO_2 pins are reported. The fuel pins are to be irradiated in an irradiation canal in the FR 2 reactor in Karlsruhe. The planned rod powers are 400 and 500 W/cm. The maximum burnup in this experiment should reach 120,000 MWd/t. Fabrication of these extremely thin fuel pins with conventional methods was possible without any difficulties. (auth)

20693 (N-72-11536) MOLYBDENUM–UO_2 CERMET IRRADIATION AT 1145°K. McDonald, G. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Oct 1971. 15p. (NASA-TM-X-67954; E-6650; CONF-711009-13). NTIS.

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971).

Two molybdenum–UO_2 cermet fuel pins were fission heated in

a helium-cooled loop at a temperature of 1145°K and to a total burnup of 5.3% of the ^{235}U. After irradiation the fuel pins were measured to check dimensional stability, punctured at the plenums to determine fission gas release, and examined metallographically to determine the effect of irradiation. Burnup was determined in several sections of the fuel pin. The results of the postirradiation examination indicated: there was no visible change in the fuel pins on irradiation under the above conditions; the maximum swelling of the fuel pins was less than 1%; there was no migration of UO_2 and no visible interaction between the molybdenum and the UO_2; and approximately 12% of the fission gas formed was released from the cermet cone into the gas plenum. (auth) (STAR)

20694 (ORNL-TM-3588) MICROSTRUCTURE OF SOL-GEL-DERIVED $(U,Pu)O_2$ MICROSPHERES AND PELLETS. Lackey, W. J.; Bradley, R. A. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 26p. Dep. NTIS.

The microstructure of sintered $(U,Pu)O_2$ microspheres and pellets prepared by the sol-gel process was characterized using light and electron microscopy, electron microprobe analysis, and alpha autoradiography. The material is typically homogeneous in composition, and the grain size is usually between 1 and 5 μm. Coarse microspheres have densities greater than 95% of theoretical, but the fine microspheres approach theoretical density. The microstructure of low-density pellets consists of high-density and medium-density regions in a porous matrix. (auth)

20695 (ORO-3912-5) COMPUTER EXPERIMENT STUDIES ON MECHANISMS FOR IRRADIATION INDUCED DEFECT PRODUCTION AND ANNEALING PROCESSES. Progress Report, June 1-August 31, 1970. Beeler, J. R. Jr. (North Carolina State Univ., Raleigh). 1971. Contract AT(40-1)-3912. 66p. Dep. NTIS.

Evolution of the primary damage state produced by the accumulation of independently produced, single Frenkel pairs was simulated using a Monte Carlo method. The results indicate that the development of embryo void nuclei is an inevitable consequence of approaching a saturated damage state. The defect population saturated in the sense that the time average number of defects leveled off at a value equal to the crystal volume divided by the volume of the annihilation region for a vacancy and an interstitial. Large local fluctuations in the defect population occurred in subvolumes comparable to the size of the region from which the vacancy supply for the formation of a void nucleus is drawn. This seed region is typically 10^3 to 10^4 atomic volumes in size. In these fluctuations, the defect population varied from a level 35% smaller than the time average saturation level to 68% larger than the time average saturation level. Void nucleation can occur in the case of a large positive fluctuation provided this fluctuation takes place in the vicinity of impurity atoms which would stabilize the void nucleus. Rare gas atoms and carbon atoms serve this purpose, for example. (auth)

20696 (PWAC-482(Pt.2)) SWELLING OF IRRADIATED UC AND UN. Huegel, F. J. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). Oct 1965. Contract AT(30-1)-2789. 20p. Dep. NTIS.

An analysis of SNAP-50 uranium carbide and uranium nitride fuel swelling was performed according to a method developed by Foreman (AERET/M134, March 1956). Better agreement of observed and predicted fuel swelling was found for uranium carbide than for uranium nitride. (auth)

20697 (SC-RR-710048) TECHNIQUE FOR SPUTTERING THIN-FILM TRANSPARENT ELECTRODES. Snelling, J. B. (Sandia Labs., Albuquerque, N. Mex.). Jul 1971. 9p. Dep. NTIS.

A method of sputtering indium oxide thin films to obtain transparent electrodes was developed. These transparent films adhere very well to optically polished substrates and typically exhibit sheet resistivity of 20 ohms per square. (auth)

20698 (WARD-4210-T-3-1) OXIDE FUEL ELEMENT DEVELOPMENT. Quarterly Progress Report for the Period Ending December 31, 1970. Anderson, C. A. Jr.; Bishop, E. C.; Boltax, A.; Ray, W. E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Mar 1971. Contract AT(30-1)-4210. 158p. Dep. NTIS.

Results of analytical and experimental studies on mixed oxide fuel pins are presented. Information and data are included on radiation effects testing of fuels, development of design codes for mixed fuels, radiation testing of mixed oxide fuel pins, development of grid-type fuel assemblies, fabrication and testing of LMFBR fuels, fabrication of EBR-II-type subassemblies, development of tooling, fuel pellet fabrication, oxide fuel characterization, and quality control. (J.R.D.)

20699 (WARD-4210-T-3-9) PELLET SELECTION TO MINIMIZE SMEAR DENSITY VARIATION WITHIN THE FUEL ELEMENT. McGeary, R. K. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Oct 1971. Contract AT(30-1)-4210. 14p. Dep. NTIS.

A Fortran IV computer program was written to make calculations for more than 8000 fuel pellets. The information was needed for smear density control of pellets selected for fuel pin loading for irradiation testing. For each pellet the output lists included pellet density, smear density, diameter, and length; data were sorted and listed in ascending order for each characteristic in order to simplify handling. For pellet batches, the means, standard deviations, and listings for easy construction of population histograms were available as output. The frequency distributions were used to select individual pellets for loading into cladding tubing. The scheme described was based on minimizing pellet density variations from the top to the bottom of each pellet stack, as well as minimizing variations between the pellet stacks from any batch. (auth)

20700 PRODUCTION OF COARSE-GRAINED CRYSTALLINE UO_2 OF HIGH DENSITY BY ELECTROCHEMICAL REDUCTION OF UO_2Cl_2 IN A KCl-NaCl MELT. Eichler, B. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 14: No. 7-8, 253-6(Jul-Aug 1971). (In German).

Precipitation of UO_2 on Cr-Ni wire cathodes at 750°C was studied. The electrolyte was prepared by reaction of UO_2 or U_3O_8 with an air-carbon tetrachloride mixture in equimolar KCl-NaCl melt. Reversibility and polarization properties of the electrode UO_2/UO_2Cl_2, KCl-NaCl, ... was studied by determining the electrode potential as a function of concentration and plotting the current-potential curve for a UO_2Cl_2 concentration of 20% by weight. The current density of production process most favorable with respect to crystal shape of the precipitate is 80 to 250 mA cm^{-2}. Crushed product (particle diameter ≦1 mm) has a particle density of (10.92 ± 0.04) g cm^{-3} and, after washing, a chloride content of (170 ± 90) ppM. Use of a wire cathode allows the product and electrode material to be separated easily and completely. (auth)

20701 DOMESTIC PRODUCTION OF NUCLEAR FUEL RUNNING EXPERIMENT JUDGEMENT. BWR. Imai, R. (Japan Atomic Power Co., Tokyo). Genshiryoku Kogyo; 17: No. 9, 16-19(Sep 1971). (In Japanese).

BWRs are employed in a number of nuclear power plants in Japan and domestic fuel is used in these power stations, however their manufacture is mostly based on foreign technology. Problems in domestic production of the nuclear fuel for the BWR plants are described. It is noted that fuel, though produced in Japan, is produced on the basis of the foreign technology, and is used for imported reactors. Japan lacks test data on the produced fuel; the results available are mostly foreign. Needs for acquisition of techniques, reduction in cost, and quality-control improvement are indicated. (Japan)

20702 THERMODYNAMIC PROPERTIES OF NONSTOICHIOMETRIC COMPOUNDS FROM THE POINT OF VIEW OF INDISTINGUISHABILITY OF IONS (ATOMS) IN DIFFERENT VALENCE STATES. Shishkov, V. I.; Zhikharev, V. M.; Kozheurov, V. A. pp 7-13 of Fiziko-Khimicheskie Osnovy Proizvodstva Stali. /Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

Equations for the chemical potentials of components in the nonstoichiometric oxides FeO_{1+x}, MnO_{1+x}, and UO_{2+x}, the sulfides TiS_{2-x} and Co_4S_{3+x}, the carbide ThC_{1-x}, and the nitride Cr_2N_{1-x}, were obtained on the basis of indistinguishability of ions (atoms) of differing valence. The hypotheses were confirmed using thermodynamic data taken from the literature. (tr-auth)

20703 REDUCING PROPERTIES OF VANADIUM, NIOBIUM, AND TANTALUM IN LIQUID IRON. Narita, K.; Koyama, Sh. pp 26-32 of Fiziko-Khimicheskie Osnovy Proizvodstva Stali. /Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The reducing properties of V, Nb, and Ta in liquid iron and the composition of the reduction products were determined from the equilibrium between liquid metal and a vapor-hydrogen mixture of known composition. The results showed that the reducing properties increased in the order V, Nb, Ta, and their effect on the oxygen activity increased similarly. (tr-auth)

20704 THERMODYNAMICS OF REDUCTION PROCESSES IN METAL OXIDES. Chufarov, G. I.; Men, A. N.; Balakirev, V. F.; (and others). pp 148-53 of Fiziko-Khimicheskie Osnovy Proizvodstva Stali. /Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The mechanisms and phase equilibria of the reduction of complex oxides with a spinel structure were studied. The solid phases involved the oxides of Fe, Mn, V, Cu, and Mg. A thermodynamic analysis of such equilibria was made with the assumption that one phase was characterized by a varying composition. Results obtained from a statistical thermodynamic treatment were compared with those derived directly from the experimental data. (tr-auth)

20705 CHEMICAL BONDS AND THE THEORY OF SLAG STRUCTURE. Chuiko, N. M. pp 164-7 of Fiziko-Khimicheskie Osnovy Proizvodstva Stali. /Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The structural theory of slags is discussed in connection with ionic and covalent bonds involving both thermal and electrolytic dissociation. The theory agrees very well with all physico-chemical properties of molten slags of different composition, and permits a determination of the active concentrations of slag components and the distribution of elements between metal and slag. Oxides of metals that are discussed include BeO, MgO, CaO, TiO_2, MnO, SiO_2, FeO, and MgO. (K.S.W.)

20706 ELECTROCHEMICAL MACHINING OF TUNGSTEN CARBIDE–COBALT ALLOYS BY MEANS OF AN ALTERNATING ASYMMETRICAL CURRENT. Levin, A. I.; Nechaev, A. V. Elektron. Obrab. Mater.; No. 1, 12-15(1971). (In Russian).

The electrochemical machining of hard alloys of the WC–Co type using an asymmetrical ac current was studied. The ionization over-voltage of the hard alloy was reduced and the rate of anodic dissolution accelerated by using this type of current. Use of an asymmetrical current ensured a high degree of finish of the alloy surface and also increased the current efficiency. Reasons for the improvements thus achieved are discussed. (Metals Abstr.)

20707 EFFECT OF ULTRASONIC VIBRATIONS ON THE ANODIC DISSOLUTION OF HARD ALLOYS. Chaika, G. V. Elektron. Obrab. Mater.; No. 6, 23-8(1970). (In Russian).

Experimental data relating to the effects of ultrasonic oscillations on the efficiency with which the waste material is removed in the electro-chemical machining (hole-drilling) of hard alloys (WC–TiC–TaC–Co) are presented and analyzed, the oscillations having a frequency of 20 kHz. The amplitude of the ultrasonic vibrations has a major effect on the efficiency of anodic dissolution for electrode gaps of 0.05–0.30 mm in width. The greatest intensification of the rate of anodic dissolution was obtained for an amplitude of 7 to 10 μm. (Metals Abstr.)

20708 STUDIES ON THE SINTERING BETWEEN PbO AND PZT. 5. EFFECT OF THE FORMING PRESSURE ON SINTERING. Yamaguchi, Osamu; Shimomura, Shigeo (Doshisha Univ., Kyoto). Funtai Oyobi Funmatsuyakin; 18: No. 3, 95-9(Sep 1971). (In Japanese).

The effects of the forming pressure on the sintering between PbO and PZT were investigated with a thermal dilatometer, an electron microscope, and by measurement of the isothermal shrinkage and the electro-mechanical coupling coefficient. The extent of the expansion and the shrinkage on heating depended on the forming pressure. The forming pressure gave the influence to the rearrangement stage, but not to the solution-reprecipitation and the grain growth of PZT which proceeded under nearly the same process. The best values for the physical properties (sintered density, apparent porosity, and water absorbing ratio) were attained with increase in the forming pressure. In case of the hydrostatic press, better values were obtained than in case of the usual forming method. It was found that there exists a close relation between the sintered density and the electro-mechanical coupling coefficient; the latter was based on the polarizing conditions. (auth) (Japan)

20709 STUDIES ON THE SINTERING BETWEEN PbO AND PZT. 6. THE FORMATION OF PZT AND THE SINTERING UNDER THE ATMOSPHERE OF OXYGEN. Yamaguchi, Osamu; Ohashi, Yasuo (Doshisha Univ., Kyoto). Funtai Oyobi Funmatsuyakin; 18: No. 3, 100-4(Sep 1971). (In Japanese).

Results are presented from investigations of PZT sintering under oxygen with regard to the nonstoichiometry resulting from an excess PbO (massicot, β-PbO). It was found that the formation of PZT increased under the atmosphere of oxygen, which could be explained in terms of Hedvall's effect. The heating behavior of the excess β-PbO in the starting powder was described as: in oxygen, β-PbO → β-PbO + intermediate phase (570 ~ 720°C) → α-PbO and in air, β-PbO → β-PbO + α-PbO → β-PbO + α-PbO + intermediate phase (700 ~ 730°C) → α-PbO. The temperature at which a liquid phase appeared on heating agreed with that at which all of the excessive β-PbO in the starting powder were converted into α-PbO. The dielectric constant of specimens sintered under the atmosphere of oxygen had a higher value than that of specimens obtained in the air. (auth) (Japan)

20710 STUDIES ON THE SINTERING BETWEEN PbO AND PZT. 7. EFFECT OF THE CALCINATION ON SINTERING. Yamaguchi, Osamu (Doshisha Univ., Kyoto). Funtai Oyobi Funmatsuyakin; 18: No. 4, 145-9(Nov 1971). (In Japanese).

Results are presented concerning the effects of wet and dry pulverization methods on sintering nonstoichiometric PZT with an excess PbO. The test powders contained 1.0 PbO : 0.48 TiO_2 : 0.52 ZrO_2 (molar ratio) and were calcined at 600 and 800°C before sintering. Abnormal expansion was not found in specimens of calcined powders. The shrinkage of specimens calcined at 800°C and treated by the wet method was smaller than that of the others, indicating that a mechanochemical reaction between PZT powders and water takes place. For this reason, the sintered density of such specimens was lower at temperatures up to 900°C. A linear relation between crystal grain growth and sintering time was found, the slope of which was 0.25 ~ 0.28. The electro-mechanical coupling coefficients were 47 ~ 50% with regard to the sintered bodies pulverized by the dry method after having been calcined at 800°C. (auth) (Japan)

20711 RESEARCH INTO THE KINETICS OF UO_3 REDUCTION BY HYDROGEN. Jovanovic, Djura; Milosavljevic, Jovan. Nukl. Energ.; 6: No. 1, 13-18(1970-1971). (In Serbo-Croatian).

An investigation was carried out on the reaction kinetics of UO_3 in a hydrogen atmosphere. Use was made of UO_3 obtained by the calcination of ammoniumdiuranate, and UO_3 obtained by denitration of $UO_2(NO_3)_2 \times 6H_2O$ solution. The process was followed isothermally using a thermoscale at 350, 420, 490, 570, 590, and 660°C as well as at permanent heating to 650°C. The temperature of the initial reduction was determined as well as its mechanism. The reduction of UO_3 (ADU) is carried out in two termogramically defined processes. The first process is characterized by the reduction of UO_3/U_3O_8, which takes place in an interval from 350 to 450°C, while the second process is characteristic for the reaction of U_3O_8/UO_2 which is completed at 530°C. Contrary to this, UO_3(DN) is more inert to hydrogen and under the same conditions it is reduced in one process, the reaction beginning at 430 and ending at 650°C. In both cases the reaction mechanism suits the process at the phase boundary. (auth)

20712 BEHAVIOR OF TUNGSTEN CARBIDE–COBALT COMPOSITIONS UNDER HIGH PRESSURE. Contre, M.; Coster, M.; Deschanvres, A.; Pons, L. Powder Met. Int.; 3: No. 1, 33-5 (Feb 1971).

Examination of broken 6% Co and 94% WC specimens showed the presence of Co deficient areas. To study porosity modification extruded and sintered specimens of the same alloy were compressed at 300 to 1200 kgft/mm^2. Permanent deformation was found to be independent of the porosity above a certain pressure. For 6% Co compacts permanent deformation appeared from 600 kfgt/mm^2. The variation of crack length with applied pressure showed a clear maximum fragility at ~600 kgft/mm^2. (Metals Abstr.)

20713 DEPENDENCE OF COERCIVE FORCE UPON MICROSTRUCTURE IN TECHNICAL HARDMETAL ALLOYS. Walter, P.; Grewe, H. Powder Met. Int.; 3: No. 2, 88-90(May 1971).

The physical connection between coercive force and formation of the Co-rich binder phase in the structure of WC–Co alloys was studied. The coercive force of composite materials with a ferromagnetic binder phase and non-magnetic inclusions is discussed. The relationship is considered in relation to a commercial WC–TaC–Co alloy and certain factors are discussed together with their significance in such alloys. (Metals Abstr.)

20714 REGION OF EXISTENCE AND LATTICE COMPLETION OF CUBIC VANADIUM OXYNITRIDE. Potorochin, A. A.; Shveikin, G. P.; Alyamovskii, S. I. (Inst. of Chemistry, Sverdlovsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 8, 1206-8(Aug 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 8, 1355-7(Aug 1971).

The region of existence of single-phase cubic (NaCl-type) vanadium oxynitride was investigated at 1200 to 1300°C and 10^{-3} mm Hg. The concentration dependence of the lattice period was determined from the indexes of nitrogen and oxygen. The degree of completion of the unit cell of vanadium oxynitride was also determined. (auth)

20715 CRYSTALLIZATION IN THE SYSTEM La_2O_3–GeO_2. Gutkina, N. G.; Kozhina, I. I.; Shmatok, L. K. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 8, 1228-31(Aug 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 8, 1382-5(Aug 1971).

Studies on the system La_2O_3–GeO_2 showed three crystallization fields: GeO_2, $La_2Ge_3O_9$, and $La_2Ge_2O_7$. Layer separation was observed at an La_2O_3 content of 1 to 15 mole %. (auth)

20716 EFFECTS OF VARIOUS CATIONS ON THE REACTION KINETICS OF THE SYSTEMS La_2O_3–NiO AND Pr_2O_3–NiO. Kniga, M. V.; Rubinchik, Ya. S.; Zaretskaya, R. A. (Belorussian State Univ., Minsk). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 8, 1235-7(Aug 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 8, 1389-92(Aug 1971).

The effects of cations of various valences on the kinetics of the solid-phase reactions in the systems La_2O_3–NiO and Pr_2O_3–NiO were studied at 900 to 1300°C. The results showed that the addition of 1 mole % of Li_2O, Cr_2O_3, or Ga_2O_3 increased the degree of conversion of the oxides at the start of the process. The action of the additives was strongest at 900°C. The addition of 1 mole % of Li_2O reduced the activation energy of the reaction by about 7 to 8 kcal/mole. The addition of chromic oxide to NiO increased the microhardness of the specimen by a factor of two. (auth)

20717 CRYSTALLIZATION IN THE SYSTEM Ta_2O_5–GeO_2. Gutkina, N. G.; Kozhina, I. I.; Shmatok, L. K. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 8, 1232-4(Aug 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 8, 1386-8(Aug 1971).

Studies were made on crystallization in GeO_2–Ta_2O_5 in the region 0 to 25 mole % Ta_2O_5. X-ray line-intensity patterns revealed that the system contains two crystalline forms. Compositions with less than 2.5 mole % Ta_2O_5 had a predominance of lines characteristic of GeO_2; beginning at 5 mole % Ta_2O_5, lines of a solid solution based on β-Ta_2O_5 became increasingly intense, and at 10 mole % Ta_2O_5 this solid solution was already the principal crystalline phase. At 20 mole %, irrespective of the conditions Ta_2O_5 was present only as a solid solution based on β-Ta_2O_5. An approximate equilibrium diagram of the system GeO_2–Ta_2O_5 for the region 75 to 100 mole % GeO_2 was constructed. (P.C.H.)

20718 PHASE DIAGRAM AND CRYSTALLINE PHASES IN THE SYSTEM HfO_2–Y_2SiO_5. Grebenshchikov, R. G.; Parfenenkov, V. N. (Inst. of Silicate Chemistry, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 8, 1238-41(Aug 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 8, 1393-7(Aug 1971).

Phase equilibria in the pseudobinary system HfO_2–Y_2SiO_5 were studied, and the phase diagram was constructed using the method of annealing and quenching, x-ray diffraction, and crystalooptical analysis. It was established that the system HfO_2–Y_2SiO_5 contains several types of solid solutions with finite solubility: an HfO_2-based monoclinic solid solution with limiting Y_2SiO_5 content of about 1.5 mole% and a cubic solution of HfO_2 with a concentration range of 53–83 mole% HfO_2, the concentration boundaries of which are given only approximately owing to experimental difficulties. The system displayed peritectic and eutectic equilibria. A temperature of 1800 ± 15°C and a composition of 17.5 mole% HfO_2 corresponded to the eutectic. (auth)

20719 PREPARATION AND INVESTIGATION OF A HYPEREUTECTIC ALLOY OF ZIRCONIUM CARBIDE AND GRAPHITE. Fekhretdinov, F. A.; Belevich, I. S.; Kudintseva, G. A.; Kuznetsova, G. M. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 8, 1296-7(Aug 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 8, 1457-8(Aug 1971).

Alloys of ZrC–graphite were prepared by melting in an atmosphere of argon in an electric-arc vacuum furnace. To reduce losses of material on fusion (due to sputtering), and to improve the fusion conditions, the mixture of ZrC and graphite powders was dry-briqueted into tablets. The thermal stabilities of the ZrC–graphite alloys were determined by cyclic heating of the specimens (d = 25 mm, H = 2 mm) in a plasma burner. It was found that specimens of the eutectic alloy lasted for 10 cycles and those of hypereutectic alloy for 25 to 30 cycles as compared to 1 and 5 cycles, respectively for pure ZrC and graphite. Studies also showed that the addition of graphite did not appreciably reduce the emissive capacities of cathodes based on ZrC. It was concluded that hypereutectic alloys of ZrC–graphite can be used as efficient thermocathodes in apparatus with cyclic operating conditions. (P.C.H.)

20720 REGION OF EXISTENCE OF AN OXYCARBIDE PHASE IN THE SYSTEM Zr–C–O. Klimashin, G. M.; Kozlovskii, L. V.; Chiu, A. K. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 7, 1663-5(Jul 1971).

Translated from Zh. Prikl. Khim.; 44: No. 7, 1644-6(Jul 1971).

The region of existence of the ZrC_xO_y phase has been tentatively determined. The character of variation of the lattice constant of zirconium carbide with the vacancy and oxygen concentrations showed that it is necessary to take into account the influence of oxygen on the performance characteristics (electro- and thermophysical) and on the design aspects in the use of zirconium carbide, which is finding increasing applications in various branches of technology. (auth)

20721 LOW TEMPERATURE SPECIFIC HEATS AND RELATED THERMODYNAMICAL FUNCTIONS OF LANTHANUM DIHYDRIDE $LaH_{2.00}$. CRYSTAL-FIELD EFFECTS IN CERIUM DIHYDRIDE $CeH_{2.00}$. Bieganski, Z. (Inst. for Low Temperature and Structural Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 19: No. 9, 581-6(1971).

The low temperature specific heats of two samples of lanthanum dihydride, $LaH_{2.00}$ and $LaH_{2.03}$, were measured by adiabatic calorimetry. For $LaH_{2.00}$ the specific heat at constant pressure C_p, the entropy S^0, enthalpy function $(H^0-H_0^0)$, and Gibbs function $-[(F^0-H_0^0)/T]$ at 298.15 are: 10.46 cal $mole^{-1}$ deg^{-1}, 12.35 cal $mole^{-1}$ deg^{-1}, 1800 cal $mole^{-1}$, and 6.28 cal $mole^{-1}$ deg^{-1}, respectively. Broad and diffuse anomalies in the temperature range 170 to 270°K were observed for both samples of the dihydride. The influence of the crystal field of cubic symmetry on the splitting of the ground state $^2F_{\frac{5}{2}}$ of the Ce^{3+} ion in cerium dihydride was analyzed and it was concluded that the quartet Γ_8 is the lowest lying level, which supports the anionic-like character of hydrogen in this hydride. (auth)

20722 ELECTRON-MICROSCOPE STUDY OF FORMATION OF GADOLINIUM MONOXIDE SINGLE CRYSTALS. Rai, Kailash Nath; Srivastava, O. N. (Banaras Hindu Univ., India). Mater. Sic. Eng.; 8: No. 6, 341-2(Dec 1971).

Thin GdO single crystals were grown by depositing Gd metal vapor onto freshly cleaned (100) NaCl faces at 550°C and 10^{-5} torr. The films were floated off and collected on a Cu grid for electron microscopy. The films contained a large number of cubic single crystals with a fcc lattice parameter a = 5.50 ± 0.03 Å. Under intense electron irradiation, the GdO crystals transformed to a fcc superlattice with a = 10.900 ± 0.09 Å. (D.L.C.)

20723 WEAR INVESTIGATIONS ON PLASMA-ARC-SPRAYED TUNGSTEN CARBIDE COATINGS. Hantzsche, Helmut; Zabel, Karl. Schweisstechnik (Berlin); 20: No. 12, 549-52(Dec 1970). (In German).

Sliding and jet-impingement wear tests were carried out on 20 to 100 μm WC coatings resulting from plasma-arc spraying with various types of WC. 6 and 15% Co contents gave better sliding wear-resistance than HVK powder whereas the opposite was true for jet-impingement wear resistance, i.e. HVK 03 + 11% Co was the most resistant to impingement wear. The effects of plasma-arc spraying variables on the wear-resistance values of plasma-arc sprayed WC castings are discussed. (Metals Abstr.)

20724 SOLUTION THERMODYNAMICS IN METALLIC AND CERAMIC SOLID SYSTEMS. Alcock, C. B. (Univ. of Toronto). Annu. Rev. Mater. Sci.; 1: 219-52(1971).

Examples of what has been achieved in the field of thermodynamic information and what can be done to test some models with these data are reviewed. The topics discussed include: dilute solutions of nonmetals in metals; dilute solutions of H in transition metals; solution of C in γ-Fe; binary metallic systems, such as concentrated solid solutions and intermetallic compounds; interstitial compounds; oxide systems; defect equilibrium constants; and solid solutions of oxides. (148 references). (P.C.H.)

20725 HIGH-TEMPERATURE SPECTRAL EMITTANCE OF OXIDES OF ERBIUM, SAMARIUM, NEODYMIUM, AND YTTERBIUM. Guazzoni, Guido E. (Electronic Components Lab., Fort Monmouth, N. J.). Appl. Spectrosc.; 26: No. 1, 60-5(Jan-Feb 1972).

Normal spectral emittance data are reported for solid speci-

mens of the oxides of erbium, samarium, neodymium, and ytterbium. The spectral emittance has been characterized over the spectral range of 0.5 to 5.0 μ and at sample temperatures from 1540 up to 1870°K. (auth)

20726 PRODUCING STARTING MATERIALS FOR THE MANUFACTURE OF ELECTROFUSED BAKOR REFRACTORIES. Mirkin, L. V.; Lainer, A. I.; Kolenkova, M. A.; (and others) (Inst. of Steels and Alloys, Moscow). Refractories (USSR) (Engl. Transl.); 12: No. 7-8, 424-7(Jul-Aug 1971).
Translated from Ogneupory; 12: No. 7, 12-15(Jul 1971).

A method of producing baddeleyite–corundum refractories without using added ZrO_2 is described. A granulated mixture of zircon, AlF_3 and Al_2O_3 is heated to 1130 to 1180°C in a flame furnace. Fired products of this process contain ZrO_2, Al_2O_3 and SiO_2 with traces of TiO_2. The fired materials are melted in an electric arc furnace. (J.R.D.)

20727 FUEL FABRICATION. Halle, M. L. (ASEA-ATOM, Vasteras, Sweden). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 85, 34-40(Sep-Oct 1970). (In French). (CONF-700903-20).
From fourth Foratom Congress on industrial aspects of the nuclear fuel cycle in Europe; Stockholm, Sweden (21 Sep 1970).

The overall fuel requirements of nuclear power plants are discussed. The preparation of the primary materials, the cladding, and the fabrication of structural materials, and different types of fuel are examined. Uranium metal fuel for gas-cooled reactors, and AGR and HTR type fuels for water and research reactors are considered. (auth) (France)

20728 MODEL STUDIES ON CONICAL FLUIDIZED BEDS FOR COATING OF NUCLEAR FUEL PARTICLES. Wallroth, C. F.; Gyarmati, E.; Nickel, H. (Kernforschungsanlage, Juelich, Ger.). Chem.-Ing.-Tech.; 43: No. 24, 1298-1304(Dec 1971). (In German).

The pyrolytic coating of nuclear fuel particles is carried out in conical fluidized beds at temperatures up to and above 2000°C, thus precluding direct observation of movements in the bed. Principles involved in performing model studies at room temperature for simulation of the movements are reported, as are the experimental results for a solid/gas system (petunia seeds/hydrogen) using a double-channel jet system. Varying distribution of gas between the central and the annular jets permits establishment of various forms of movement. The best results with regard to uniformity of coating were obtained in coating experiments with unperturbed bubble movement. (auth)

20729 METALLOGRAPHIC PREPARATION OF HIGHLY ACTIVE CERAMIC FUELS. Enderlein, H.; Hellriegel, W.; Pejsa, R. (Nuclear Research Center, Karlsruhe, Ger.). KFK Nachr.; 3: No. 2, 26-30(1971). (In German).

Sample pretreatment and preparation for masses of irradiated UO_2, PuO_2, and UC are described for metallographic analysis. Methods for imbedding of the sample in bakelite, grinding with silicon carbide paper, and subsequent polishing, cleaning and drying are described. The use of a HNO_3–H_2O_2 etching fluid to render grain boundaries visible in the irradiated fuel is outlined, and several 200 x photographs of UO_2 and $(U,Pu)O_2$ fuel specimens are furnished. (K.S.W.)

20730 PLUTONIUM. Von Bonsdorff, M. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 86, 5-17(Nov-Dec 1970). (In French). (CONF-700903-25).
From fourth Foratom Congress on industrial aspects of the nuclear fuel cycle in Europe; Stockholm, Sweden (21 Sep 1970).

The use of Pu for the initial loading of fast reactors will not take place before ten years time. The factors determining the politics, for the maximum exploitation of Pu in Europe, are presented. Transfers in the open or restricted market, fuel manufacturing and recycling, and research and development in relation to the use of Pu in thermal reactors are discussed. (France)

20731 RESEARCH AND DEVELOPMENT OF JAPANESE PRODUCTION OF NUCLEAR FUEL. Mishima, Y. (Tokyo Univ.). Genshiryoku Kogyo; 17: No. 9, 8-11(Sep 1971). (In Japanese).

Research and development progress on nuclear fuel has been made in Japan for about 15 years. Fuel has been produced for research reactors, however, manufacture for commercial power plants has been limited. For domestic production of the nuclear fuel, close coordination between user utility companies and manufacturers is essential. The research, development, and manufacture during the past 15 years are reviewed including efforts devoted to fuel and structural materials by educational institutions, research institutes, and private enterprise. Activity in Nuclear Fuel Safety Committee of Japan Atomic Industrial Forum, dealing mainly with zirconium and stainless steel cladding tubes, is discussed. The joint studies in the committee contributed greatly to establishment of manufacturing techniques in Japan. (Japan)

20732 PROBLEMS OF JAPANESE PRODUCTION OF NUCLEAR FUEL IN FUTURE. Matsushita, H. (Ministry of International Trade and Industry, Tokyo). Genshiryoku Kogyo; 17: No. 9, 4-7(Sep 1971). (In Japanese).

In order to attain the goal of nuclear power generation in Japan, it is necessary to establish a sound industry fuel cycle. The present state of nuclear fuel production, especially its fabrication, for light-water reactors in Mitsubishi Atomic Power Industry, Japan Nuclear Fuel Co., and Sumitomo Electric Industries is reviewed. At the present time, besides very low production capacity, demonstration of manufactured fuel in commercial power reactors has not been achieved and orders from utility companies have been small. In order to nurture the nuclear fuel industry in Japan, it is essential to consolidate relations among the manufacturers and to initiate a joint development effort to utilize manpower and research funds effectively. Production of Zircaloy cladding tubes is described briefly. (Japan)

20733 ANALYSIS OF FABRICATION PROCESSES ON Al–U_3O_8 DISPERSION. Cintra, Sebastiao Hermano Leite; Gentile, Erberto Francisco; Nishioka, Isao; Abrao, Marco Antonio de Souza; Ambrosio Filho, Francisco (Instituto de Energia Atomica, Sao Paulo, Brazil). Metalurgia (Sao Paulo); 16: No. 146, 31-43 (Jan 1970). (In Portuguese). (IEA-203).

Based on previous experience gained in the fabrication of aluminum-clad, U_3O_8–Al dispersion fuel plates, the parameters that should be analyzed in the various phases of the production, in order to determine the influence of each one, were examined. The recognized parameters are: the composition and the characteristics of the materials employed, fabrication of the cermet, assembly of the components, and the characteristics of the roll bonding technique utilized. After analysis of each parameter, the results obtained with a given U_3O_8 powder are presented and discussed. The results show the importance of the powder utilized to withstand the stresses during the rolling process. (auth)

20734 PREPARATION AND STUDY OF THE DIBORIDES OF Ti, Zr, AND Hf. Favre, R.; Thevenot, P. (Univ. Lyon, Villeurbanne, France). Bull. Soc. Chim. Fr.; No. 11, 3911-16(Nov 1971). (In French).

The diborides of Ti, Zr, and Hf and the mixed diboride, TiB_2–ZrB_2, were prepared by the reaction of B with metallic dioxides between 1600 and 1900°C at 10^{-4} torr. Thermodynamic studies of this reaction together with mass spectrometry indicated that the low oxide, B_2O_2, must be considered. Traces of O, H, N, C, Si, and Fe were found in the products. The O content of the diborides was decreased by adding C to the reaction mixture. Some of the properties of these diborides were studied. The absence of oxyborides and solid solutions in TiB_2 was demonstrated. (France)

20735 RELATIONSHIP BETWEEN TOTAL AND OPEN POROSITY IN THE SINTERING OF MATERIALS COMPOSED OF A CARBIDE AND AN IRON-GROUP METAL. Petrova, E. M.; Shcherban, N. I. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 8, 633-5 (Aug 1971).
Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 8, 48-51(Aug 1971).

A study was made of the relation between total and open porosity in the sintering of metal–carbide materials (Mo_2C and NbC and Fe, Co, Ni) in a wide range of concentrations of their starting components. It was found that the dependence of the ratio of open and closed porosities on relative density (for sintered materials, τ = 0.6 to 0.8) is practically linear and that the parameters characterizing it show a good correlation with the solubility of carbides in metals. (auth)

20736 COEFFICIENT OF THERMAL EXPANSION OF REFRACTORY COMPOUNDS. Samsonov, G. V.; Grebenkina, V. G.; Klimenko, V. S. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 8, 643-7(Aug 1971).
Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 8, 61-6(Aug 1971).

The coefficients of thermal expansion (CTE) of the transition metals and refractory compounds are discussed. The CTE of alloys of the system TaC–WC and some compounds of the system ZrC–WC were measured and the relation of CTE to the electronic structure of the components of refractory compounds was analyzed. The results showed that the CTE and rate of increase of the CTE with rise in temperature, $d\alpha/dT$, of solid solutions in the

systems TaC–WC and ZrC–WC decrease with rise in WC content up to the limit of existence of solid solutions owing to the intensification of directional covalent bonding in the M–M bond, attaining a minimum value in the system TaC–WC for the composition $Ta_{0.3}W_{0.7}C$. Thus, CTE and $d\alpha/dT$ decreases as an electronic structure with the least fraction of nonlocalized electrons and maximum localization of valency electrons in stable configurations appears in the solid solution structure. (P.C.H.)

20737 PROPERTIES OF COMPLEX TiC–WC CARBIDES IN THEIR HOMOGENEITY REGION. II. PHYSICOMECHANICAL PROPERTIES. Chaplygin, F. I.; Vitryanyuk, V. K. (Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 8, 653-6(Aug 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 8, 73-6(Aug 1971).

Studies were made on the room-temperature microhardness, microbrittleness, and electric conductivity of TiC-base–WC alloys in their homogeneity region. The results showed that the microhardness and the brittleness index of the alloys increased with rise in the amount of combined C and decreased with rise in the amount of WC. The electric conductivity of the carbide alloys fell with rise in the amount of combined C. This is due to the fact that, as the Me–C bonds became strengthened (and the Me–Me bonds weakened), the proportion of unlocalized electrons (current carriers) fell and scattering of carriers on the stabilized sp^3 configurations decreased, which led to a reduction in electric conductivity. (P.C.H.)

20738 MICROHARDNESS OF SOME CARBIDES AT VARIOUS TEMPERATURES. Koval'chenko, M. S.; Dzhemelinskii, V. V.; Skuratovskii, V. N.; (and others) (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 8, 665-8(Aug 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 8, 87-91(Aug 1971).

A study was made on the effects of temperature on the microhardness of titanium, niobium, and tungsten carbides in a wide temperature range (from 73 to 1973°K). The relationship obtained is described by the Trefilov–Mil'man equation established for the transition metals and covalent crystals. An analysis has been made of the relationship between the microhardness of titanium, niobium, and tungsten carbides and temperature, and values of energy of activation, activation volume, and potential barrier width have been estimated. (auth)

20739 SLIP SYSTEM DETERMINATION IN CUBIC CARBIDES BY HARDNESS ANISOTROPY. Hannink, R. H. J.; Kohlstedt, D. L.; Murray, M. J. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A; 326: No. 1566, 409-20(25 Jan 1972).

Hardness was examined as a function of indenter orientation on the (001) surfaces of the cubic transition-metal carbides titanium carbide, vanadium carbide, zirconium carbide and niobium carbide. To emphasize the observed anisotropy a Knoop indenter was used. Experiments were performed in the temperature range –196 to 610°C. The anisotropy curves obtained at each temperature were analyzed in terms of operative slip systems. Three different temperature régimes for the anisotropy were identified. These correspond to the $\{110\}\langle 1\bar{1}0\rangle$ slip system for the low-temperature régime, the $\{111\}\langle 1\bar{1}0\rangle$ slip system for the high-temperature régime and a combination of these two systems for the intermediate-temperature régime. To explain this change in slip system it is proposed that an important temperature dependent change in bonding occurs. A qualitative model is suggested for this change in which an increased density of high mobility electrons increasingly screens the directional covalent bonds as the temperature is raised. (auth)

20740 METHOD FOR THE MANUFACTURE OF INORGANIC THERMAL INSULATION. Asbury, Joseph J.; Googin, John M. (to United States Atomic Energy Commission). U. S. Patent 3,634,563. 11 Jan 1972. Filed 13 Mar 1970.

This invention relates to an inorganic thermal insulating product of a density less than 25 pounds per cubic foot and a thermal conductivity factor of less than 0.5 Btu-in./ft²-hr-°F at a temperature of 1500°C. The product is prepared by mixing minute silicon oxide particles with inorganic fibers, an organic liquid which wets the surface of the particles and inhibits crystallization and hydration of the particles, and a quantity of octanoic acid. The organic liquid and a portion of the octanoic acid are evaporated, with the remaining octanoic acid being retained. The mixture is ground and then pressed into a desired configuration of essentially final dimensions, with the octanoic acid flowing during the pressing step to act as a binder for the silicon oxide particles. After pressing the compact is lightly sintered in an inert atmosphere during which virtually all, if not all, of the remaining octanoic acid volatilizes. (Official Gazette)

20741 DIFFUSION COATINGS FORMED BY CARBONITRIDES OF TANTALUM AND ZIRCONIUM ON STEEL. Sintsova, I. T.; Kozlovskii, L. V. (Leningrad Technological Inst.). Zashch. Metal.; 6: No. 3, 367-71(May–Jun 1970). (In Russian).

Powdered mixtures of Ti and Zr with alumina were used to form coatings on 30XGSA and 3AXGSNA steels in an Ar atmosphere at 900 to 1150°C. Photomicrographs of the coatings are discussed; their thicknesses ranged from 60 to 130 μ after an eight-h heat treatment at 1150°C. Carbonitrides were also formed at 800°C, and their structures were studied by x-ray diffraction. (K.S.W.)

20742 CONDITIONS OF PREPARATION OF BORIDES OF THE PLATINUM-GROUP METALS. Samsonov, G. V.; Kosenko, V. A. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 8, 614-18(Aug 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 8, 25-30(Aug 1971).

Thermal and x-ray phase analyses were carried out to determine the conditions of reactive sintering of components resulting in the formation of borides of the platinum-group metals. It was established that the reactive sintering temperature steadily falls as the d level of the platinum-group metals fill up. (auth)

20743 EFFECT OF SINTERING ON THE PROPERTIES OF UO_2. Nishioka, Isao (Instituto de Energia Atomica, Sao Paulo, Brazil). Metalurgia (Sao Paulo); 26: No. 156, 889-95(Nov 1970). (In Portuguese). (IEA–223).

Studies on the effects of the comminution of UO_2 powders in ball mills and the influence on the sintering of the ground powders in fixed conditions are reported. The results are discussed with reference to the influence of milling time on specific surface of the powder, O/U ratio, and density of the sintered pellets obtained at fixed sintering conditions. (auth)

20744 DISPERSION-HARDENED MATERIALS: TECHNICAL STATUS. Steinhaeuser, Siegfried. Neue Huette; 16: No. 12, 733-9(Dec 1971). (In German).

By "dispersion-hardened material" (DHM) is meant a metal such as Al, Mg, or an alloy containing a hard, finely-divided material as a second phase, such as dispersed UO_2, ThO_2, or ZrO_2. Other examples of DHM's include W, Ta, Nb, or Mo as the matrix, with dispersed oxide, nitride, carbide, or boride. Fiber-reinforced and whisker-reinforced materials are introduced as techniques by which extraordinary durability is produced by the presence of mono- or polycrystalline whiskers. The several methods of producing DHM's are described, accompanied by examples of each method. (110 references) (K.S.W.)

20745 HOT PRESSING OF UO_2–PuO_2. de Freitas, C. T.; Ayer, J. E.; Petkus, E. J. (Argonne National Lab., Ill.). Metalurgia (Sao Paulo); 26: No. 148, 183-7(Mar 1970). (In Portuguese). (IEA–225).

Studies of 85% UO_2–15% PuO_2 hot pressing in the 1000 to 1500°C temperature range are described. The operations were conducted in graphite dies at variable pressures between 110 and 290 kg/cm². The temperature influence on volume decrease and density was determined. For the oxide mixture considered, the largest volume decrease rate was found at 930°C. 19 mm side square plates and 25.4 mm diameter discs were produced. Three plates were prepared by multispecimen hot pressing. In spite of the graphite die utilization, the carbon absorption in the not pressed plates was generally under 500 ppM. The ceramographic study showed that the carbon was distributed principally near the samples surface. The oxygen/metal ratio decreased during the pressing operations. The largest density values, corresponding to 95% of the theoretical value, were obtained for an operation conducted at 1500°C for 30 minutes, at 270 kg/cm² pressure. Ceramography showed that good UO_2–PuO_2 mixture homogeneity can be obtained. (auth)

20746 SINTERING OF ThO_2 AND ThO_2–UO_2 SOLID SOLUTIONS. Haydt, Heliton Motta; Capocchi, Jose Deodoro Trani; Moraes, Eduardo; Gentile, Erberto Francisco (Instituto de Energia Atomica, Sao Paulo, Brazil). Metalurgia (Sao Paulo); 26: No. 157, 959-63(Dec 1970). (In Portuguese). (IEA–236).

The sintering of ThO_2 and ThO_2–UO_2 solid solution pellets, prepared with thorium oxide by calcination of thorium oxalate, was carried out with the purpose of comparing the results with those of earlier work. In the previous studies, thorium dioxide prepared from thorium sulfate was utilized. Sintering was done in air and in an argon atmosphere. In current work, factors in-

fluencing ThO_2 sinterability are analyzed and the characteristics of the powders used are determined. Based on the study of the sintering results of both series, it is concluded that the formation of solid solutions is due to the vaporization of the oxide UO_3. (auth)

20747 KINETICS OF HETEROGENEOUS THERMAL DECOMPOSITION OF ZIRCONIUM AND HAFNIUM BORON HYDRIDES. Grigor'ev, V. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Kinet. Katal.; 12: No. 4, 1042-5(Jul-Aug 1971). (In Russian).

Samples of $Zr(BH)_4$ and $Hf(BH)_4$ were synthesized and used in a study of the kinetics of their decomposition over the temperature range 200 to 300°C. The variables controlled were: temperature, time, total gas pressure, and amount of nonvolatile material remaining on the surface of the sample. The rate constants of the heterogeneous decomposition, the energy of activation, and the enthalpy of activation were measured. (K.S.W.)

20748 INVESTIGATION OF THE SYSTEM V_2O_5–$K_2S_2O_7$ UNDER CONDITIONS OF SO_2 OXIDATION. Bazarova, Zh. G.; Boreskov, G. K.; Ivanov, A. A.; Karakchiev, L. G.; Kochkina, L. D. (Inst. of Catalysis, Novosibirsk, USSR). Kinet. Katal.; 12: No. 4, 948-52(Jul-Aug 1971). (In Russian).

Mixtures of V_2O_5 and $K_2S_2O_7$ were heated to a temperature in the range 350 to 610°C while exposed to a gaseous mixture of 81.5% N_2, 11% O_2 and 7.5% SO_2 for reaction periods of 24 or 48 h. Chemical analyses and ir spectra showed that varying the conditions of reaction produced the series of compounds: $6K_2O \cdot V_2O_5 \cdot 12SO_3$, $K_2O \cdot V_2O_5 \cdot 2SO_3$, $K_2O \cdot V_2O_5 \cdot 4SO_3$, or $K_2O \cdot V_2O_4 \cdot 3SO_3$. (K.S.W.)

20749 ELECTROMIGRATION OF CARBON IN BERYLLIUM. Gladkov, V. P.; Zotov, V. S.; Skorov, D. M. At. Energ. (USSR); 32: No. 2, 163-4(Feb 1972). (In Russian).

The electromigration of carbon in polycrystalline beryllium with a grain coarseness of 56 μ was studied. The effective charges in Be were −26.5, −0.164 and −0.254 at 1273, 1373, and 1473°K, respectively, where the effective charge is a function of the Coulomb charge of the atom, mean free path of the electrons, scattering cross section of foreign atoms, and other factors. (K.S.W.)

20750 THERMOPHYSICAL PROPERTIES OF AN Al_2O_3–Mo CERMET. Osipova, V. A.; Kyaar, Kh. A. At. Energ. (USSR); 32: No. 2, 162-3(Feb 1972). (In Russian).

The thermal conductivities of the two cermets Al_2O_3 − 20% Mo and Al_2O_3 − 40% Mo were determined over the temperature range 473 to 1273°K. Comparisons were made with calculated values. Microstructural analyses of cermet samples showed that particles of Mo were disseminated throughout a matrix of Al_2O_3. (K.S.W.)

20751 THERMODYNAMIC PROPERTIES OF REFRACTORY CARBIDES IN THE TEMPERATURE RANGE 0 TO 3000°K. I. TANTALUM CARBIDE. Turchanin, A. G.; Guseva, E. A.; Fesenko, V. V. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 10, 823-5(Oct 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 10, 75-7(Oct 1971).

Results of research directed toward the calculation, on the basis of published data, of reliable values of heat capacity of TaC which are acceptable as reference data are reported. Use was made of low-temperature data on $TaC_{1.0}$. A comparison of calculated and experimental high-temperature data is included. (J.R.D.)

20752 PROPERTIES OF THORIA-BASE DISPERSIONS. Haydt, Heliton Motta; Cintra, Sebastiao Hermano Leite; Capocchi, Jose Deodoro Trani; Abrao, Marco Antonio de Souza; Bueno, Ricardo Pedro de Antunes (Instituto de Energia Atomica, Sao Paulo, Brazil). Metalurgia (Sao Paulo); 26: No. 147, 121-6 (Feb 1970). (In Portuguese). (IEA-224).

Progress in programs concerning the behavior of the cermets containing thoria-base dispersions is summarized. The previous results have demonstrated the advantage of utilizing only the thorium oxalate as raw material for the ThO_2–U_3O_8–Al dispersion, in three different mixture compositions. An examination of the ThO_2 powder, classified at the 200 mesh screen, showed that the grains were considerably smaller than the screen size, with particle sizes less than 11 μ. The research is directed to fabrication of plates with homogeneous cores which could be used as reactor fuel elements. The production of powders with particles of larger sizes was studied directed toward cermet fabrication, for use in plate-type fuel elements. (auth)

20753 FABRICATION OF URANIUM DIOXIDE HELICES FOR IRRADIATION CREEP MEASUREMENTS. Dusek, J. T.; White, G. D. (Argonne National Lab., Ill.). Amer. Ceram. Soc. Bull.; 51: No. 2, 148-51(Feb 1972).

Low-enrichment, uranium-dioxide wire helices were fabricated to measure irradiation creep. Helices composed of 10 or 20 turns of wire were fabricated by slip casting in plaster molds, which yielded a trapezoidal cross section, and by vacuum extrusion, which yielded a circular cross section. The outside diameter of a helix was 0.875 to 0.9375 in.; the diameter of the wire was 0.079 in. Immersion densities of the slip-cast helices were 92 to 93% of theoretical, and those of the extruded were 95 to 97%. The fabrication procedures are described. Microstructures for both types of helices are presented. (auth)

20754 DISSOCIATION PRESSURES AND RELATED THERMODYNAMIC FUNCTIONS AND HYDROGEN SOLUTION PARAMETERS IN THE SYSTEMS PrH_2–PrH_3, NdH_2–NdH_3, AND SmH_2–SmH_3. GENERAL CONSIDERATIONS FOR THE RELATED LANTHANIDE AND ACTINIDE HYDRIDE SYSTEMS. Messer, C. E.; Park, M. K. (Tufts Univ., Medford, Mass.). J. Less-Common Metals; 26: No. 2, 235-46(Feb 1972).

The hydrogen dissociation pressures have been measured as functions of composition and temperature for the face-centered cubic phases of praseodymium, neodymium, and samarium hydrides at 250 to 450°C, hydrogen-to-metal ratios 2.2 to 2.7, and pressures 50 to 760 torr. The magnitudes of the pressures for the first two systems are close to those of the lanthanum and cerium hydride systems; the samarium hydride pressures are considerably higher. Enthalpies and entropies of solution $\overline{H}_H - \frac{1}{2}H^0_{H_2}$ and $\overline{S}_H - \frac{1}{2}S^0_{H_2}$ were evaluated from Van't Hoff plots. Interaction energies between octahedral interstices and octahedral hydrogen atoms were evaluated from regular solution theory and compared with literature-based calculations for the corresponding lanthanum, cerium, neptunium, plutonium, and americium systems. All interaction energies were negative (attractive), of the order 1 to 3 kcal $mole^{-1}$. In the lanthanum, cerium, and praseodymium hydride systems, the interaction energies decreased with increasing temperature; in the other systems the interaction energies increased with temperature to about 350°C, then decreased. The resulting entropy effects are discussed. The transition from cubic to trigonal (hexagonal) samarium hydride was detected and investigated at high hydrogen-to-metal ratios, but the existence of considerable hysteresis precluded equilibrium measurements. (auth)

20755 COEFFICIENTS OF THERMAL EXPANSION OF CUBIC (NaCl TYPE) OXYCARBIDES AND OXYNITRIDES OF ZIRCONIUM AND HAFNIUM. Zainulin, Yu. G.; Alyamovskii, S. I.; Shveikin, G. P.; Gel'd, P. V. High Temp. (USSR) (Engl. Transl.); 9: No. 3, 496-9(May-Jun 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 3, 546-9(May-Jun 1971).

The temperature dependence (between 25 and 900°C) of the lattice parameters and the mean coefficients of linear thermal expansion are reported for eight samples of cubic (NaCl-type) oxycarbides and oxynitrides of zirconium and hafnium. It was found that the values of α_{av} increase in the series $MeC_x - MeC_xO_y$ and $MeN_x - MeN_xO_y$ owing to a weakening of the energy of atomic interaction and the complexity of the lattice in the phases concerned. Provisional values of the melting point, elastic modulus, and characteristic temperature are also given for four specimens of MeC_xO_y. (auth)

20756 CARBOTHERMIC REDUCTION OF THORIUM OXIDE. Kanno, Masayoshi; Ozaki, Satoru; Matsuda, Fumio; Kokubo, Sanya; Mukaibo, Takashi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 2, 97-102(Feb 1972).

The carbothermic reduction in vacuum of thorium dioxide with graphite has been studied with the aid of a high temperature thermobalance at temperature range of 1,300 ~ 1,900°C. The effects of differences in the reaction temperature, molecular ratio of the reactants, and in the state of the reactants such as differences between loose powder mixture and pelleted form were examined. The reaction rate obeyed the diffusion-controlled kinetic equation, and an activation energy of 75 ± 4 kcal/mole was obtained as a mean value of all the different cases covered. Some x-ray analyses of the product were carried out, which revealed a final product of ThC phase alone resulting from the C/ThO_2 mole ratio of 3, while with ratio of 4 the product contained a mixture of ThC and ThC_2. The reaction mechanism is also discussed briefly. (auth)

20757 INFLUENCE OF OXIDE PARTICLES ON THE SINTERING CHARACTERISTICS OF CARBONYL IRON. Singh, B. N.; Houseman, D. H. Powder Met. Int.; 3: No. 1, 26-9(Feb 1971).

Comparative investigations were made of the sintering behavior of carbonyl Fe powder with and without dispersions of TiO_2, Al_2O_3, or ZrO_2. Tests conducted at 1350 to 490°C showed that TiO_2 aided densification at the lowest temperature and hindered at higher temperatures. Both Al_2O_3 and ZrO_2 hindered densification at all temperatures but ZrO_2 was the most effective. (Metals Abstr.)

20758 INVESTIGATION OF THE VAPORIZATION OF POLYCRYSTALLINE CADMIUM. Matern, G.; Priselkov, Yu. A.; Sapozhnikov, Yu. A. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 5, 557-61(Sep-Oct 1971). (In Russian).

The vaporization of cadmium samples with different content of impurities was studied by Knudsen effusion method in the temperature range 410 to 500°K. The temperature dependences were found to display abrupt changes in equilibrium vapor pressure values due to the rupture of the oxide film. The rate of effusion was found to decrease with the growth of Zn content in the samples at low values of total resistance of effusion cell to the molecular flow. (auth)

20759 INVESTIGATION OF ZrO_2 CONVERSION PRODUCTS IN CARBON DIRECT CURRENT ARC. Tarasevich, N. I.; Semenenko, K. A.; Khramova, G. T. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 5, 623-5(Sep-Oct 1971). (In Russian).

The behavior of ZrO_2 in a carbon dc arc was studied by x-ray analysis. The final product of the physicochemical conversion was shown to be monoclinic ZrO_2. A simplified scheme describing the behavior of ZrO_2 in free-burning dc arc is suggested. (auth)

20760 THERMAL EXPANSION OF ABO_4-COMPOUNDS WITH ZIRCON- AND SCHEELITE STRUCTURES. Bayer, G. (Eidgenoessische Technische Hochschule, Zurich). J. Less-Common Metals; 26: No. 2, 255-62(Feb 1972).

The structural relationship between zircon- and scheelite-type compounds is discussed. Both structures show identical oxygen coordination of A- and B-ions (8 and 4), the scheelite structure however is more densely packed than the zircon structure and has a layer-like arrangement of the cations. This is in agreement with the thermal expansion results which showed that, generally, all scheelite compounds have much higher thermal expansion in the c-direction than corresponding zircon compounds. The magnitude of the thermal expansion is determined primarily by the cation valencies. Compounds containing uni- or divalent A-ions had much higher thermal expansion than compounds with 4-valent cations. The highest thermal expansion coefficients were found for $NaIO_4$(S), $CaCrO_4$(Z), and for the scheelite-type tungstates. $ThGeO_4$(Z) had the lowest thermal expansion of all compounds investigated, followed by $TaBO_4$. (auth)

20761 EFFECT OF TiC AND TaC ADDITIONS IN THE WC + Co-BASE COMPOSITIONS FOR WIRE DRAWING DIES. Herscovici, P.; Radu, S. I.; Zamfirescu, Cristina; Marculescu, B.; Crisan, Ana Maria. Cercet. Met.; 11: 1033-47(1970). (In Rumanian).

Laboratory- and industrial-scale experiments regarding the effects of TiC and TaC additions in the WC + Co composition with a view to improving the service life of drawing dies were carried out. A method of radiometric measurement was developed for the determination of the wear rate of the drawing die. (Metals Abstr.)

20762 COMPARATIVE ACTIVITY OF RARE EARTH OXIDES IN THE OXIDATION OF CO. Sultanov, M. Yu.; Sadykova, Kh. A. (Azerbaydzhan Inst. of Petroleum and Chemistry, Baku). Azerb. Khim. Zh.; No. 1, 110-12(1971). (In Russian).

The oxides of La, Ce, Pr, Nd, Sm, Gd, Dy, Ho, Er, Tm, Y, Lu, and Cu were prepared and the specific surface of each was determined. The catalytic activity of each oxide was evaluated by determining the degree of oxidation of CO as a function of temperature over the interval 500 to 650°C. The rare earth oxides proved to be much less active than CuO. (K.S.W.)

20763 SPHEROIDIZATION TIMES OF SOME REFRACTORY OXIDES. Draganescu, V.; Alexandrescu, R.; Comaniciu, N.; Georgescu, C. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 10, 1229-34(1971). (In Rumanian).

A mathematical model of supercooling was used for estimating the times involved in the solidification process of the droplets of different sizes, created during the spheroidization of some refractory oxides. The results were compared with experimental data available in literature. (auth)

20764 SOLUBILITY OF Be IN CUBIC CARBIDES OF Ti, V, Nb, AND Ta. Zainulin, Yu. G.; Alyamovskii, S. I.; Shveikin, G. P.; Shchetnikov, E. N.; Gel'd, P. V. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 20, 68-70(1970). (In Russian).

The interaction of Be with $TiC_{0.65}$, $TiC_{0.91}$, $VC_{0.8}$, $NbC_{0.77}$, and $TaC_{0.76}$ (having a rock salt structure) at 1100 and 1500°C in a vacuum is discussed. With the exclusion of Ti carbide, cubic solid solutions were formed. The periods of the lattice of the latter increased with increase in Be content. (tr-auth)

20765 SYSTEM Zr–C–O. Alyamovskii, S. I.; Zainulin, Yu. G.; Shveikin, G. P.; Gel'd, P. V.; Shchetnikov, E. N. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 20, 60-7(1970). (In Russian).

The conditions of formation of the systems Zr–C, Zr–O, and Zr–C–O and their structural characteristics from the literature were compared. Suggestions are made for further investigation, particularly relative to the structural characteristics of zirconium oxycarbide. (42 references) (K.S.W.)

20766 MUTUAL SOLUBILITY OF SOME INTERMEDIATE OXIDES OF TRANSITION METALS OF THE IVa AND Va SUBGROUPS. Perelyaev, V. A.; Shveikin, G. P. Tr. Inst. Khim., Akad. Nauk SSSR, Ural. Filial; No. 20, 47-53(1970). (In Russian).

A survey of the literature showed that for the system TiO_2–VO_2 the region of mutual solubility of NbO_2 is extensive but bounded. However, in the system Ti_2O_3–V_2O_3 complete mutual solubility exists. Solid solutions with a cubic lattice of monoxides, $TiO_{1.0}$–$VO_{1.0}$ are not formed. In the systems Ti_2O_3–V_2O_3 and TiO_2–VO_2, NbO_2 is observed to form solid solutions of substitution based on corundum or rutile types, respectively. Solid solution behavior in these systems was scrutinized for different valence composition both of separate phases and in the formation of solid solutions. (tr-auth)

20767 HIGH TEMPERATURE OXIDES. PART IV. REFRACTORY GLASSES, GLASS–CERAMICS, AND CERAMICS. Alper, Allen M. (ed.). Refractory Materials. A Series of Monographs. Volume 5. New York; Academic Press, Inc. (1971). 266p. $16.50.

Nine chapters are included; a separate abstract was prepared for each of two. The remaining seven chapters contain information on: refractory glasses; refractory glass–ceramics; mullite; oxide spinels; zinc oxide; slip-cast ceramics; and theory of glass networks. Separate author and subject indexes are also included. (P.C.H.)

For abstracts of individual chapters see: 20768 and 20769.

20768 OXIDES CONTAINING TUNGSTEN. Phillips, Bert (LeMont Scientific, Inc., Lemont, Pa.). Refract. Mater.; 5: 109-29(1971).

A review is presented on simple tungsten oxides and on complex tungsten oxides. Phase diagrams are given for W–O, BeO–WO_3, MgO–WO_3, CaO–WO_3, SrO–WO_3, BaO–WO_3, Co–W–O, Ti–W–O, Y_2O_3–WO_3, Sm_2O_3–WO_3, ZrO_2–WO_3, HfO_2–WO_3, and Nb_2O_3–WO_3. (P.C.H.)

20769 ZIRCONIA–ALUMINA–SILICA REFRACTORIES. Begley, Edward R.; Herndon, Philip O. (Corhart Refractories Co., Louisville, Ky.). Refract. Mater.; 5: 185-208(1971).

A review is presented on the fabrication, properties, characteristics for glass industry service, and uses of Al_2O_3–SiO_2–ZrO_2 refractories. The phase diagram of the refractory is also given. (P.C.H.)

Metals and Alloys

20770 ABSTRACTS OF PAPERS PRESENTED AT THE FIFTH ANNUAL INFORMATION MEETING OF THE HEAVY SECTION STEEL TECHNOLOGY PROGRAM, OAK RIDGE NATIONAL LABORATORY, MARCH 25–26, 1971. Nucl. Eng. Des.; 17: No. 1, 170-8(1971). (CONF-710342-(Absts.).

From fifth annual information meeting of the heavy section steel technology program; Oak Ridge, Tenn. (25 Mar 1971).

Abstracts of 31 papers presented are included. Generally the papers contain information on mechanical properties, fabrication, radiation effects, and inspection of steel and steel pressure vessels. (P.C.H.)

20771 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Januar 1972. Band 6, Heft 1. 151 Referate (Register-Nr.1-274), 103 Referate (Register-Nr.1T-103T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. January 1972. Vol. 6, No. 1. 151 Abstracts (Register No. 1-274), 103 Abstracts (Register No. 1T-103T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1972). 109p. (In German and English).

Corrosion and Erosion

20772 (EURFNR-954) INVESTIGATIONS OF THE CORROSION BEHAVIOR OF AUSTENITIC CrNi STEELS AND NICKEL ALLOYS IN SUPERHEATED STEAM. Leistikow, S. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report KFK-1463, 32p. Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The results of studies on the corrosion behavior of chromium-nickel steels and nickel-base alloys in superheated steam showed that they are very much influenced by previous treatment of the metal and the operating conditions. The factors considered, such as oxygen content in the superheated steam, degree of cold working, and grain size of the material, were all evidence of this. Austenitic Cr-Ni steels exhibited a variable resistance of superheated steam corrosion. The nickel-base alloys (Incoloy 800, Inconel 625, Inconel 718, Inconel 600, and Hastelloy 255) exhibited extremely good corrosion resistance. It was concluded that in choosing a suitable material for steam superheaters at surface temperatures between 600 and 700°C, it appears desirable under both conventional and nuclear conditions to use a cold-worked Cr-Ni steel with 20% Cr and 20 to 30% Ni. (P.C.H.)

20773 (MLM-1864) COMPATIBILITY OF $^{238}PuO_2$ WITH VARIOUS NICKEL AND COBALT BASE ALLOYS. Schaeffer, D. R. (Mound Lab., Miamisburg, Ohio). 10 Jan 1972. Contract AT(33-1)-Gen-53. 203p. Dep. NTIS.

Results from a compatibility study between production grade $^{238}PuO_2$ with various nickel- and cobalt-base alloys are presented and discussed. The alloys are Hastelloy N, Hastelloy X, Haynes 25, Haynes 188, Inconel 625, and TD nickel. Test temperatures were 800 and 1000°C with thermal exposures up to 360 days. Suggested interpretation of the data and resultant mechanisms are given. (auth)

20774 (PWAC-342) NaK CORROSION INVESTIGATION OF SELECTED BIMETALLIC SYSTEMS. Austin, George W. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 30 Jun 1961. 26p. Dep. NTIS.

To evaluate the liquid metal compatibility of secondary circuit container materials 13 bimetallic forced convection loop systems comprised of both Nb-1 Zr alloy in conjunction with Type 316 stainless steel, and Nb-1 Zr alloy with Haynes alloy No. 25 were tested with high temperature NaK. Approximately 8200 hours of operation were accumulated by these systems at maximum NaK temperatures to 1650 and 1800°F, respectively, at temperature differentials of 400 and 500°F. This testing was conducted in the air atmosphere test stands at CANEL. In general, it was observed that those bimetallic systems fabricated from Nb-1 Zr alloy and Haynes alloy No. 25 and tested at 1800°F were slightly more susceptible to corrosion than those fabricated from Nb-1 Zr alloy and Type 316 stainless steel and tested at 1600°F. Corrosion in these systems appeared mainly to involve solution of carbon and nitrogen from the Haynes alloy and stainless steel and reaction to form carbides and nitrides of niobium. Metal transfer from stainless steel and Haynes alloy occurred only to a slight extent. Limited data were obtained in a program to determine the effects of carbon and nitrogen transfer on the mechanical properties of the subject materials. Tensile and elongation properties at 1600°F for Nb-1 Zr alloy and Haynes alloy No. 25 following exposure in bimetallic forced convection loops generally fell within the normal scatter band for these materials when not exposed to NaK. Minor changes in strength associated with carbon and nitrogen transfer were suggested by the data. The strength properties for Type 316 stainless steel were generally below the normal scatter band presumably as a result of the loss of carbon and nitrogen. (auth)

20775 (TID-11893) TYPE 316 STAINLESS STEEL INPILE FORCED CONVECTION LIQUID METAL CORROSION TESTS; NSSA-1A1, NSSA-2A2, NSSB-1A1, AND NSSB-3A3. Coyle, G. E. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 16 Dec 1958. 21p. (FXM-3915). Dep. NTIS.

NaK was pumped through four test loops constructed of Type 316 stainless steel to determine the ability of the stainless steel to resist corrosion with NaK at test conditions similar to those of the liquid metal inpile loop (PW-19). The four loops, which contained heater and cooler sections so that temperature gradients could be established in the NaK circuit, operated at maximum NaK temperatures of 1660 and minimum temperatures of 1530°F. The maximum corrosion attack in the four loops, which occurred as sub-surface voiding, ranged from 0.8 to 1.5 mils except for a local area downstream of the expansion tank tee in the hot isothermal zone of loop NSSB-1A1 where it was 4.0 mils. Maximum deposits (mass transfer) ranged from none in loop NSSB-3A3 to 4.5 mils in depth in loop NSSA-2A2. From the standpoint of corrosion resistance, type 316 stainless steel appears to be a satisfactory container material for NaK at the test conditions of these loops. Neither the corrosion attack nor the mass transfer deposits had any measurable effect on the heat transfer characteristics or NaK flow rate of the loops. (auth)

20776 (TID-11896) CORROSION RESISTANCE OF HAYNES ALLOY NO. 25 IN HIGH TEMPERATURE NaK AND LITHIUM. Donnelly, E. H.; Slotnick, H. (Pratt and Whitney Aircraft, Middletown, Conn.). 20 Apr 1959. Contract AT(11-1)-292. 2p. (FXM-4041). Dep. NTIS.

The corrosion resistance of Haynes 25 Alloy was studied after exposure to high temperature Na-K and Li in thermal convection loops and tilting capsules. In a thermal convection loop in 1600°F Na-K, the corrosion resistance of Haynes 25 appeared substantially the same as that of Type 316 stainless steel. In 1800 and 1900°F tilting capsules with 400°F thermal gradients, examination revealed less than 2 mils subsurface void attack and no mass transfer. Under similar test conditions with Li, Haynes 25 exhibited poor corrosion resistance as evidenced by high tab weight loss and extensive mass transfer. (P.C.H.)

20777 OXIDATION SEQUENCE OF IMPURITIES OF NATURALLY-ALLOYED CAST IRON. Shchekalev, Yu. S.; Pastukhov, A. I.; Popel, S. I.; Shakirov, K. M. pp 191-5 of Fiziko-Khimicheskie Osnovy Proizvodstva Stali. /Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The relative oxidation rates in iron-carbon melts containing Si, Ti, V, and Cr, respectively, by oxygen-containing gaseous mixtures were investigated. Such relative oxidation rates of the four elements were determined by the surface concentrations and the affinity for oxygen. A lowering of the oxidation rates for V and Cr with a decrease in partial pressure of the oxidizing agent was principally due to the formation of oxides with less affinity for oxygen. The rate of absorption of the oxidizing agent by the melt was fixed by peculiarities inherent in the chemisorption act. (tr-auth)

20778 ROLE OF DISSOLVED OXYGEN IN THE CORROSION OF NIOBIUM AND TANTALUM BY LIQUID SODIUM. Addison, C. C.; Baker, M. G.; Wood, D. J. (Univ. of Nottingham, Eng.). J. Chem. Soc., A; No. 1, 13-16(1972).

The corrosion of niobium and tantalum in liquid sodium is strongly influenced by the quantity of dissolved oxygen in the liquid metal. The oxides Na_3TaO_4 and Na_3NbO_4 were identified on the surface of tantalum and niobium after immersion in liquid sodium containing dissolved oxygen at temperatures in excess of 300°C. The oxides were identified by their x-ray powder diffraction patterns, which were recorded through a matrix of sodium. Measurement of the lattice constant of the underlying transition element enabled the extent of oxygen solid solution to be calculated. The formation of an oxide, together with oxygen in solid solution, enables a mechanism of corrosion for niobium and tantalum in the presence of liquid sodium to be established. (auth)

20779 GROWTH OF TUNGSTEN CRYSTALS BY VAPOR DEPOSITION IN HALOGEN INCANDESCENT LAMPS. Neumann, G. M. (OSRAM, Munich). Metall; 25: No. 12, 1347-51(Dec 1971). (In German).

Increased rates of vaporization at "hot spots" on a tungsten filament in a lamp result in a transport reaction and the growth of tungsten crystals from the vapor phase (containing halogen) and the formation of many bizarre shapes. A screen-electron microscopy process was used to make enlarged photographs of such growth shapes, and 24 black-and-white halftones which depict the range of forms available are reproduced. The discussion includes a comparison with tungsten deposits previously reported. (K.S.W.)

20780 KINETICS OF THE ZIRCONIUM-OXYGEN ACTIVE COMBUSTION SYSTEM. Maloney, Kenneth M. (General Electric Co., Cleveland). High Temp. Sci.; 3: No. 6, 445-55(Nov 1971).

Microscopic rate formulations were derived with use of a simplified finite reaction zone model for the process of active combustion of a liquid zirconium metal droplet. Application of the rate expressions to the single drop zirconium-oxygen combustion system illustrates the fact that the active combustion of the zirconium metal drop proceeds via a diffusion flame mecha-

nism. It is shown that the major portion of the required energy is expended in a vaporization step and that oxidation and active combustion are simply opposite limiting conditions of the same basic phenomenon. (auth)

20781 CORROSION SCIENCE, 1970. Vermilyea, David A. (General Electric Co., Schenectady, N. Y.). Annu. Rev. Mater. Sci.; 1: 373-98(1971).

The status of corrosion science is reported. Emphasis is on the physical picture rather than mathematical formulation, and the discussion is limited to corrosion in aqueous solutions. The topics discussed include: solution-solid interface; active corrosion; cathodic reactions; adsorption; inhibition by adsorption; reaction product formation; properties of reaction products; inhibition by reaction products; intergranular attack; pitting and crevice corrosion; and stress corrosion cracking. (132 references). (P.C.H.)

20782 DEPOSITION OF CORROSION PRODUCTS ON ZIRCONIUM ALLOY SURFACE. Gerasimov, V. V.; Gromova, A. I.; Morozova, I. K.; (and others). At. Energ. (USSR); 32: No. 1, 15-18(Jan 1972). (In Russian).

The experimental rate of deposition of corrosion products on zirconium alloy surface as a function of coolant composition, exposure time, temperature, and irradiation is presented in comparison with the published data. It has been shown that the deposition rate of iron corrosion products is essentially influenced by the property of oxide film formed on zirconium alloy and corrosion product content in the coolant. The deposition rate does not depend upon oxygen concentration in the coolant, irradiation, or the potential in the passive region when the heat flux is absent. (auth)

20783 SUPERHEATED STEAM CYCLE FOR CORROSION TESTING UNDER HEAT TRANSFER CONDITIONS. Erbacher, F.; Leistikow, S. KFK Nachr.; 3: No. 2, 6-12(1971). (In German).

A corrosion test installation was designed to simulate the conditions of a vapor-cooled breeder reactor i.e., 300 atmospheres pressure and a superheat of 520°C. Provision is made for a steam generator, purification and degassing of the feed water. A brief description of the control and measuring devices is given. The current test program and objectives are outlined. (K.S.W.)

20784 SINTERED NICKEL–CHROMIUM–MOLYBDENUM ALLOYS. II. CORROSION RESISTANCE. Solonin, S. M.; Chernyshev, L. I.; Kopylova, V. P.; Fedorchenko, I. M. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 8, 657-60(Aug 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 8, 77-81(Aug 1971).

Studies were made on the optimum composition at which Ni–Cr–Mo alloys exhibit high corrosion resistance in reducing solutions (HCl) and an oxidizing acid (HNO_3). The results showed that the addition of chromium adversely affected the corrosion resistance of the alloys in hydrochloric acid, but improved their corrosion resistance in nitric acid; on the other hand, molybdenum made the alloys more immune to attack by hydrochloric acid and reduced their corrosion resistance in nitric acid. The introduction of a component lowering the corrosion resistance of an alloy in a given acid accelerated the dissolution of the alloy component which was normally resistant to attack by this acid. The metal dissolved in the acids differed markedly in composition from the starting alloy; nickel and chromium dissolved in the acids at approximately the same rate, which, however, was markedly different from the dissolution rate of molybdenum. Thus, it was the molybdenum that was responsible for the difference in composition between the starting and dissolved alloys. Of all the sintered nickel–chromium–molybdenum alloys investigated, the Ni–15% Cr–15% Mo alloy was found to exhibit the highest combined corrosion resistance to hydrochloric and nitric acids. (auth)

20785 INFLUENCE OF TITANIUM ON CORROSION RESISTANCE AND PHYSICAL-MECHANICAL PROPERTIES OF VANADIUM. Andreeva, V. V.; Stepanova, T. P.; Druzhinina, I.; Vladimirskaya, T. M. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 175-81(1971). (In Russian).

Results are presented from studies of the physical and mechanical properties, structure, corrosion resistance, and electrochemical behavior of alloys in the system V–Ti with 10 to 90% Ti content. (JPRS)

20786 INFLUENCE OF TECHNOLOGICAL FACTORS ON CORROSION RESISTANCE AND MECHANICAL PROPERTIES OF NIOBIUM–TANTALUM ALLOYS. Dontsov, S. N.; Moiseeva, I. S.; Mel'nikova, L. V.; (and others). Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 152-60(1971). (In Russian).

The results of studies on the influence of technological factors on the corrosion resistance of Nb–Ta alloys are reported. (JPRS)

20787 CORROSION RESISTANCE OF 2- AND 3-COMPONENT VANADIUM ALLOYS IN BOILING SOLUTIONS OF INORGANIC ACIDS. Vorob'eva, L. P.; Druzhinina, I. P.; Gulyaev, A. P. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 168-74(1971). (In Russian).

The rate of corrosion of V and V alloys with Ti, Ta, Mo, and W in boiling solutions of hydrochloric, sulfuric, phosphoric, and nitric acids at various concentrations was determined. (JPRS)

20788 STUDIES ON THE CORROSION BEHAVIOR OF ZIRCONIUM ALLOYS. PART 1. BEHAVIOR AGAINST AQUEOUS MEDIA. Jangg, G. (Technical Univ., Vienna); Baroch, E. F.; Kieffer, R.; Prem, E. Werkst. Korros.; 22: No. 10, 869-78 (Oct 1971). (In German).

Corrosion tests on 50 zirconium alloys show that the excellent corrosion resistance of pure zirconium is not improved significantly by addition of other metals. Titanium, hafnium, tin and small amounts of niobium barely influence corrosion resistance. Molybdenum, tungsten, large amounts of niobium as well as minute amounts of platinum and rhenium decrease the resistance through formation of electro-chemical currents. Iron, chromium, and nickel have practically no influence. Favorable effects are exerted by small copper additions to Zr–Mo and Zr–Nb alloys. (H.B.G.)

20789 MECHANISM OF ANOMALOUS OXIDATION OF NIOBIUM BELOW 600°C. Dekanenko, V. M.; Vavilova, V. V. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 200: No. 3, 595-7(21 Sep 1971). (In Russian).

Oxidation of Nb and Nb alloys was conducted at 300 and 500°C after various annealing histories. Kinetic curves of oxidation indicated that tempered alloys and those annealed below the oxidation temperature possessed the greatest oxidation rates. The oxidation of Nb below 600°C proceeded differently from that above 600°C; formation of the suboxide occurred only below 600°C. (K.S.W.)

20790 TECHNICAL ASPECTS OF THE FORMATION OF OXIDE LAYERS AND THEIR PREVENTION. Weber, J. Werkst. Korros.; 22: No. 8, 691-7(Aug 1971). (In German).

Corrosion prevention in steam generators in nuclear power plants is discussed. Corrosion in unalloyed and low-alloy steels in CO_2 containing CO ~2%, moisture 100 ppM, and H 100 ppM at 350 to 430°C at 30 bar follows a parabolic time scale, at least during the first 2000 to 3000 h, these alloys can therefore only be used to a limited extent. Si-killed steels are superior to rimmed steels, low S contents are also favorable. Dichromate treatment should be avoided as Cr enrichment resulting from decomposition of the dichromate enhances oxidation. The suspension of pipes can produce tensile stresses in crevices, and fretting under alternating thermal loads at the supports. Oxidation is slower in Zr–Cu alloys than in pure Zr, probably because the larger atomic volume of the Cu makes oxidation more difficult. (Metals Abstr.)

20791 WATERSIDE CORROSION IN ADVANCED DESIGNS OF NUCLEAR STEAM GENERATORS. Garnsey, R.; Hearn, B.; Mann, G. M. W. (Central Electricity Research Labs., Leatherhead, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 1, 65-70(Jan 1972).

The mechanism of oxidation of iron and steel and the formation of magnetite in high temperature water and aqueous solutions is described. Understanding of this mechanism has helped to reduce the unscheduled outage of conventional and nuclear boilers due to waterside corrosion to a low level. Possible designs for more advanced nuclear steam generators have higher thermal ratings, different tube geometry and tube wall thickness, while the penalties for tube failures are increased. The effects of these changes in design on waterside corrosion are discussed. Corrosion rates that are negligible in thick walled boiler tubes may be significant in thinner walled tubing, particularly if regular acid cleaning proves to be necessary. Those aspects of boiler design that require further studies if the risk of waterside corrosion failure in future plant is to be maintained at the present satisfactory level are discussed. (auth)

20792 CORROSION BEHAVIOR OF STRUCTURAL AND CAN MATERIALS OF FAST BREEDERS IN LIQUID SODIUM. Rettig, D. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 14: No. 11, 349-56(Nov 1971). (In German).

The main problems of interaction between sodium and struc-

tural and can materials under the operational conditions of fast breeder reactors and the recent ways to overcome them are described. Emphasis is placed on fields such as mass transfer of metallic elements, carbon transfer, corrosion in the products of sodium–water reaction in the steam generators, and abrasion and friction under sodium. Mass transfer of metals together with the mechanical strength properties of the can materials restricts maximum core exist temperature of sodium. Changes of the strength of structural materials due to carbon transfer and the consequences of steam generator component corrosion under the conditions of water–sodium reaction may endanger safety of the whole reactor system including its coolant loops. Possible ways to overcome these problems are commonly seen in control and purification systems for sodium in connection with materials and processing standards for sodium plants in which appropriate structural solutions are used. (auth)

Preparation and Fabrication

Refer also to abstracts 20073, 20147, 20701, 20728, 20731, 20732, 21572, 21581, 21582, and 22122.

20793 (CONF-711002–2) FABRICATION OF TARGET FOILS BY ROLLING TECHNIQUES. Karasek, F. J. (Argonne National Lab., Ill.). [nd]. 4p. Dep. NTIS.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

The rolling technique of target preparation has been used to prepare a vast number of self-supporting foils during the past few years. The major disadvantages of the process are: A considerable array of equipment is required; not all materials can be rolled to the thickness required; and a considerable amount of time, effort, and patience must be expended to prepare a target of the required size. These disadvantages are offset by the ability to: produce foils from minute quantities of starting material; reclaim a major portion of the scrap generated during foil fabrication; and rework previously fabricated and used targets into new target foils with little loss of valuable material. (auth)

20794 (RDT-C–16-3-T(10-71)) PPS BUFFERS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1971. 16p. RSO.

A standard prescribing requirements for plant protection instrument buffers for nuclear and associated applications is presented. (J.R.D.)

20795 (RDT-E–7-4-T(11-71)) MIXING COMPONENT FOR LIQUID METAL PIPING SYSTEMS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Nov 1971. 25p. RSO.

A standard prescribing requirements for mixing component for liquid metal piping systems for nuclear and associated applications is presented. (J.R.D.)

20796 (RDT-E–8-18-T(8-71)) THREADED FASTENERS FOR NUCLEAR COMPONENTS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1971. 7p. RSO.

A standard prescribing requirements for threaded fasteners for nuclear components for nuclear and associated applications is presented. (J.R.D.)

20797 (RDT-E–10-3-T(9-71)) TANK–LIQUID METAL SERVICE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Sep 1971. 22p. RSO.

A standard prescribing requirements for tank-liquid metal service for nuclear and associated applications is presented. This standard supersedes RDT E 10-3T, dated September 1971. (J.R.D.)

20798 (RDT-F–6-7-T(7-71)) WELDABILITY TESTS FOR MATERIALS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 13p. RSO.

A standard prescribing requirements for weldability tests for materials for nuclear and associated applications is presented. (J.R.D.)

20799 (RDT-F–6-14-T(7-71)) BRAZING FABRICATION REQUIREMENTS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 8p. RSO.

A standard prescribing requirements for brazing fabrication requirements for nuclear and associated applications is presented. (J.R.D.)

20800 (RDT-M–1-4-T(7-71)) LOW ALLOY STEEL COVERED WELDING ELECTRODES (ASME SFA-5.5 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 7p. RSO.

A standard prescribing requirements for low alloy steel covered welding electrodes (ASME SFA-5.5 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 1-4T, dated February 1969. (J.R.D.)

20801 (RDT-M–4-1-T(7-71)) CARBON STEEL CASTINGS (ASME SA-216 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 9p. RSO.

A standard prescribing requirements for carbon steel castings (ASME SA-216 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 4-1T, dated February 1969. (J.R.D.)

20802 (RDT-M–4-2-T(7-71)) AUSTENITIC STAINLESS STEEL CASTINGS (ASME SA-351 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 9p. RSO.

A standard prescribing requirements for austenitic stainless steel castings (ASME SA-351 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 4-2T, dated February 1969. (J.R.D.)

20803 (RDT-M–4-3-T(7-71)) COBALT–CHROMIUM ALLOY STEEL CASTINGS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 9p. RSO.

A standard prescribing requirements for Co–Cr alloy steel castings for nuclear and associated applications is presented. This standard supersedes RDT 4-3T, dated February 1969. (J.R.D.)

20804 (RDT-M–4-4-T(7-71)) ALLOY STEEL CASTINGS (ASME SA-217 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 9p. RSO.

A standard prescribing requirements for alloy steel castings (ASME SA-217 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

20805 (RDT-M–5-3-T(7-71)) LOW ALLOY STEEL PLATES (ASME SA-533 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 8p. RSO.

A standard prescribing requirements for low alloy steel plates (ASME SA-533 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 5-3T, dated February 1969. (J.R.D.)

20806 (RDT-M–6-1-T(7-71)) ALLOY STEEL BOLTING MATERIAL FOR LOW TEMPERATURE SERVICE (ASME SA-320 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 8p. RSO.

A standard prescribing requirements for alloy steel bolting material for low temperature service (ASME SA-320 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 6-1T, dated February 1969. (J.R.D.)

20807 (RDT-M–6-3-T(7-71)) ALLOY STEEL BOLTING MATERIAL FOR HIGH TEMPERATURE SERVICE (ASME SA-193 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 8p. RSO.

A standard prescribing requirements for alloy steel bolting material for high temperature service (ASME SA-193 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 6-3T, dated February 1969. (J.R.D.)

20808 (RDT-M–6-4-T(7-71)) ALLOY STEEL NUTS FOR BOLTING FOR HIGH TEMPERATURE SERVICE (ASME SA-194 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 8p. RSO.

A standard prescribing requirements for alloy steel nuts for bolting for high temperature service (ASME SA-194 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

20809 (RDT-M–6-5-T(10-71)) ALLOY STEEL BOLTING MATERIAL FOR SPECIAL APPLICATIONS (ASME SA-540 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1971. 7p. RSO.

A standard prescribing requirements for alloy steel bolting material for special applications (ASME SA-540 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

20810 (RDT-M-7-1-T(7-71)) MARTENSITIC STAINLESS STEEL (TYPE 403) BARS (ASTM A276 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 8p. RSO.

A standard prescribing requirements for martensitic stainless steel (Type 403) bars (ASTM A276 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDTM 7-1T, dated February 1969. (J.R.D.)

20811 (RDT-M-7-3-T(7-71)) STAINLESS STEEL BARS AND SHAPES (ASME SA-479 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 8p. RSO.

A standard prescribing requirements for stainless steel bars and shapes (ASME SA-479 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT 7-3T, dated February 1969. (J.R.D.)

20812 (RDT-M-7-4-T(7-71)) NICKEL–CHROMIUM–IRON ALLOY ROD AND BAR (ASME SB-166 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 6p. RSO.

A standard prescribing requirements for Ni–Cr–Fe alloy rod and bar (ASME SB-166 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

20813 (RDT-M-7-5-T(7-71)) COBALT–CHROMIUM–TUNGSTEN–NICKEL ALLOY ROUNDS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 9p. RSO.

A standard prescribing requirements for Co–Cr–W–Ni alloy rounds for nuclear and associated applications is presented. This standard supersedes RDT M 7-5T, dated February 1969. (J.R.D.)

20814 (RDT-M-7-7-T(7-71)) COBALT–CHROMIUM ALLOY BARS AND SHAPES. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 7p. RSO.

A standard prescribing requirements for Co–Cr alloy bars and shapes for nuclear and associated applications is presented. This standard supersedes RDT M 7-7T, dated March 1969. (J.R.D.)

20815 (RDT-M-7-8-T(7-71)) NICKEL–CHROMIUM–IRON ALLOY WIRE (AMS 5687 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 5p. RSO.

A standard prescribing requirements for Ni–Cr–Fe alloy wire (AMS 5687 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 7-8T, dated February 1969. (J.R.D.)

20816 (RDT-M-7-9-T(1-72)) ZIRCONIUM AND ZIRCONIUM ALLOY BARS, ROD, AND WIRE (ASTM B351 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 6p. RSO.

A standard prescribing requirements for Zr and Zr alloy bars, rod, and wire (ASTM B 351 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RTD M 7-9T, dated May 1970. (J.R.D.)

20817 (RDT-M-7-10-T(7-71)) NICKEL–IRON–CHROMIUM ALLOY ROD AND BAR (ASME SB-408 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jul 1971. 6p. RSO.

A standard prescribing requirements for Ni–Fe–Cr alloy rod and bar (ASME SB-408 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

20818 (RDT-M-10-1-T(1-72)) ZIRCONIUM AND ZIRCONIUM ALLOY INGOTS (ASTM B350 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 5p. RSO.

A standard prescribing requirements for Zr and Zr alloy ingots (ASM B 350 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 10-1T, dated May 1970. (J.R.D.)

20819 (RDT-M-12-4-T(1-72)) REFLECTIVE INSULATION. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 17p. RSO.

A standard prescribing requirements for reflective insulation for nuclear and associated applications is presented. This standard supersedes RDT M 12-4, dated March 1971. (J.R.D.)

20820 DOMESTIC PRODUCTION OF ZIRCALOY TUBES FOR NUCLEAR FUEL. Mishima, Y. (Tokyo Univ.). Genshiryoku Kogyo; 17: No. 9, 24-7(Sep 1971). (In Japanese).

The history of development and manufacture of Zircaloy tubes in Japan is reported. In 1955, first international conference on peaceful uses of atomic energy was held in Geneva. At that time in Japan there were only limited AEC reports and a lecture note of ASM on Zr. In 1957, 59 tons of zirconium sponge were produced in Japan and exported, and the manufacturing techniques for zirconium sponge quickly arrived at international levels. According to 1974 plans of three Japanese producers, production of 120×10^4 to 150×10^4 m/year (total) of Zircaloy tubes is scheduled. The demand for Zircaloy tubes is estimated at 250×10^4 m/year in 1985. By this time, it is estimated that FBRs will be operated economically and the demand for Zircaloy tubes will decrease. (Japan)

20821 EQUILIBRIUM POTENTIAL OF HAFNIUM IN MOLTEN ALKALI METAL CHLORIDES. Smirnov, M. V.; Puzanova, T. A.; Loginov, N. A. Elektrokhimiya; 7: No. 3, 369-71(Mar 1971). (In Russian).

The electrochemical behavior of metallic Hf in molten LiCl, NaCl, and KCl, as well as in mixtures of these chlorides, was studied by the emf method and the results were interpreted in terms of the equilibrium potential of the Hf and the effect of this parameter of the electrodeposition of the metal and its response to electrolytic refining. Thus the redox potential of the system became more electropositive with rising temperature and increasing radius of the cation in the alkali salt. The practical importance of this in refining techniques is considered. (Metals Abstr.)

20822 NOVEL TYPES OF NITRIDES AND CARBONITRIDES OF HARD METALS. Kieffer, R.; Ettmayer, P.; Freudhofmeier, M. (Technische Hochschule, Vienna). Metall; 25: No. 12, 1335-42(Dec 1971). (In German).

The manufacture of hard metals on the basis of acid-poor nitrides and carbonitrides is described. Wetting and impregnation tests yielded information for choosing suitable binding agents for given sintering conditions. The end-product metals possessed hardnesses of 1200 to 1800 kp/mm^2 and bending strengths of 85 to 135 kp/mm^2. The TiN-containing metals exhibit a gold-yellow color, and with increasing TiC content the color progressively changes to red-gold, violet, and grey. The nitrides and carbonitrides of Zr, Hf, V, Nb, and Ta were prepared but their properties did not quite attain those of Ti carbonitride. Certain complex hexagonal alloys with inclusions and the extremely hard cubic TaN appear promising. A few hard-scale alloys of Ti–Ta carbonitrides with Ni binders yield improved strength and hardness values. (tr-auth)

20823 MANUFACTURE OF MAIN COMPONENTS OF NUCLEAR STEAM SUPPLY SYSTEM. Yoshimasu, T.; Usui, Y.; Funaki, T.; Yokoyama, A. (Mitsubishi Heavy Industries, Ltd., Kobe, Japan). Mitsubishi Juko Giho; 8: No. 5, 703-10(Sep 1971). (In Japanese).

The No. 2 unit of the Mihama Nuclear Power Plant of the Kansai Electric Power Co., the first PWR-type nuclear steam supply system in Japan, is now under construction and scheduled for starting of commercial operation in July 1972. The manufacturing techniques and procedure for the main components of the unit including reactor vessel, steam generators, and pressurizer are briefly described. Techniques of press forming, heat treatment, seam welding, overlay welding, precision machining, nondestructive inspection and cleaning, and the method of quality control for maintaining the absolute quality employed in these processes are also described. (auth) (Japan)

20824 NEW RESULTS OBTAINED IN THE ELECTROLYTIC METALLIZING OF PLASTICS WITH BORON HYDRIDES. Niederpruem, H.; Klein, H.-G. Galvano. 40: No. 410, 299-307(Apr 1971). (In French).

The chemical deposition of Ni (or Co) onto ABS plastics with the aid of B hydrides and amino-boranes is described. The solutions used for etching, activation, reduction, and metallization, and the chemical mechanism of the processes involved are discussed. The processes are also applicable to polycarbonates and polypropylene. (Metals Abstr.)

20825 COMPACTIBILITY OF METAL POWDERS IN ROLLING. Katrus, O. A.; Otrok, A. I. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 8, 623-7(Aug 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 8, 36-40(Aug 1971).

Listed in order of decreasing extent to which they affect strip layering, the characteristics of the powders investigated are: particle size, presence of oxides on the particle surfaces, physical condition of the powders, and particle shape. The results showed that the susceptibility of rolled strip to layering manifests itself more clearly, other things being equal, with increasing roll diameter, and becomes apparent sooner, the higher the strip porosity. (auth)

20826 Zr Hf NEWSLETTER, JANUARY 1972. Akron, N. Y.; AMAX Specialty Metals Division (1971). 18p.

Results of research and development are reported on hafnium and zirconium. Information is included on production and uses of Hf metal, Hf alloys, Zr metal, Zr alloys, and Zr compounds. 334 references are included. (J.R.D.)

20827 METALLOGRAPHY OF URANIUM. Ambrozio Filho, Francisco; Gentile, Erberto Francisco (Instituto de Energia Atomica, Sao Paulo, Brazil). Metalurgia (Sao Paulo); 27: No. 163, 415-20(Jun 1971). (In Portuguese). (IEA-240).

The metallographic control of uranium fabrication is described. Methods for the preparation of uranium samples are studied. Manual and vibratory polishing methods are compared with electrolytic polishing. The adopted techniques for identification of carbides, oxides, nitrides, and slag inclusions are also presented. A comparison among uranium samples obtained through different processes is included. (auth)

20828 MECHANISM OF WEAR IN THE ELECTROMECHANICAL MACHINING OF METALS. Samsonov, G. V.; Paustovskii, A. V. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 10, 808-11(Oct 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 10, 55-9(Oct 1971).

Electromechanical machining was investigated using pairs of transition metals in periodic Groups IV, VI, and VII. It was found that electrode tool materials should have properties minimally associated with adhesion, and maximum tensile strength. These properties were found in Mo, W, and Ni and also in their refractory compounds. (J.R.D.)

20829 ANALYTICAL PHOTOGRAPHY OF ELECTRON BEAM WELDING. Crawford, Daniel W. (Univ. of California, Livermore). Weld. J. (N. Y.); 51: No. 2, 50s-2s(Feb 1972).

A technique for photographing electron beam welding has been developed. The pictures produced are repeatable and of acceptable quality for welding analysis. (auth)

20830 EVALUATION OF BRAZE ALLOYS FOR VACUUM TREATING-GAS QUENCHING. Burrows, Charles F.; O'Keefe, Robert (Martin-Marietta Corp., Baltimore). Weld. J. (N. Y.); 51: No. 2, 53s-63s; 89s(Feb 1972).

Results of tests conducted to develop brazing methods and braze fillers for Al alloys, steels, stainless steels, and Ti-base-Al-V alloys are reported. An Al-base alloy (No. 718) was found to be best for Al alloys; Ni-base alloy (AMS4777) for stainless steels; and Ti-base alloy (Ticuni) for Ti-base-Al-V alloys. (J.R.D.)

20831 DEVELOPMENT OF FILLER METALS AND PROCEDURES FOR VACUUM BRAZING OF ALUMINUM. Werner, W. J. (Union Carbide Corp., Oak Ridge, Tenn.); Slaughter, G. M.; Gurtner, F. B. Weld. J. (N. Y.); 51: No. 2, 64s-70s(Feb 1972).

Brazing filler metal compositions that appear to exhibit significant improvements over existing commercial compositions were developed. They can be used to braze in vacuum at temperatures lower than the flow temperatures of commercial brazing alloys and have equal or better flowability. Ternary alloys which flow on 6061 Al alloys were given particular attention. The Al-Si-In alloys exhibited flow temperatures in the range 1075 to 1095°F and the Al-Si-Y alloys exhibited flow temperatures in the range 1095 to 1140°F. Alloys in the Al-Si-Ge system were particularly promising and exhibited flow temperatures of 1020 to 1095°F. Of particular interest in this system are the 55Al-5Si-40Ge, 45Al-5Si-50Ge, and 35Al-5Si-60Ge alloys, all of which flowed at 1020°F; these flow temperatures are approximately 50°F below those of commercial alloys. (J.R.D.)

20832 ENHANCED DIFFUSION WELDING OF TD-NiCr SHEET. Holko, Kenneth H.; Moore, Thomas J. (Lewis Research Center, Cleveland). Weld. J. (N. Y.); 51: No. 2, 81s-9s(Feb 1972).

An enhanced diffusion welding method has been developed to join TD-NiCr sheet with parent metal strength at the weld. Diffusion welded joints were made in specially processed TD-NiCr that equalled the tensile-shear and creep-rupture shear strengths of the parent material at 1090°C. Previous work done without this method produced weak welds. With the enhanced diffusion welding methods, TD-NiCr sheet was diffusion welded in a vacuum hot press in a lap configuration. Specially processed TD-NiCr is preferred over commercial TD-NiCr for diffusion welding. The weld line can be eliminated with specially processed material and test specimen fracture takes place in the parent material away from the original interface. With commercial material, smooth fracture takes place at the weld line and tensile shear strength at 1090°C is low. The weld line can be eliminated when joining specially processed TD-NiCr by 600-grit sanding and electropolishing the faying surfaces prior to welding. The same surface preparation applied to commercial TD-NiCr prior to welding results in the presence of a weld line with a small degree of grain growth across the weld line. But the small, recrystallized grains at the weld line that can decrease weld strength were eliminated. A two-step weld cycle is preferred for diffusion welding TD-NiCr. The first step is the application of high pressure at relatively low temperature 30 ksi and 705°C to provide microalignment and the intimate contact at the faying surfaces required for a solid-state weld to form. The second step consists of a low pressure, high temperature 2 ksi and 1190°C diffusion heat treatment necessary for complete weld formation and grain growth across the original weld interface. (auth)

20833 METHODS FOR DIFFUSION WELDING THE SUPERALLOY UDIMET 70. Duvall, D. S.; Owczarski, W. A.; Paulonis, D. F.; King, W. H. (Pratt and Whitney Aircraft, Middletown, Conn.). Weld. J. (N. Y.); 51: No. 2, 41s-9s(Feb 1972).

The diffusion-welding characteristics of wrought and cast Udimet 700 were studied to develop methods of producing high quality, strong diffusion-welded joints in high-strength nickel-base superalloys. It was found initially that a number of factors inhibited the formation of satisfactory diffusion welds. The most serious of these was the formation during bonding of a continuous array of stable Ti(C,N) and $NiTiO_3$ precipitates at the joint interface. These produced a weak, planar joint grain boundary causing very poor joint properties. Electroplating a thin nickel interlayer on each of the mating surfaces prior to welding successfully prevented the formation of the precipitates and accelerated elimination of joint porosity because of the interlayer's softness. However, nickel interlayers produced some residual chemical and microstructural heterogeneity at the joint. Even greater improvements in joint quality were achieved by utilizing a Ni-Co alloy electroplate as the interlayer material. This resulted in better chemical and microstructural homogenization at the joint and reduced the sensitivity of joint quality to slight variations in process parameters. Concurrently, improved welding parameters were developed which more effectively migrated the joint grain boundary to the desired non-planar configuration. When welding was conducted with the improved process parameters and Ni-Co interlayers, strong void-free joints were produced in both wrought and cast Udimet 700. Results of limited testing indicated that the properties of diffusion welds in the wrought alloy approached those of the base metal in room temperature and 1400°F tensile tests. Cast alloy diffusion welds were made which exhibited ≥90% joint efficiencies in creep-rupture tests at 1400 and 1800°F. (auth)

20834 ALLOYS OF TUNGSTEN AND/OR MOLYBDENUM IN COMBINATIONS WITH COPPER AND/OR SILVER AND THEIR METHOD OF PREPARATION. (to Pfizer Inc.). British Patent 1,263,662. 16 Feb 1972. Priority date 21 Mar 1969, United States.

A method is described for the preparation of composite powders containing W and/or Mo in combination with 5 to 75% Cu and/or Ag. It includes, for example, the preparation of W-Cu, Mo-Cu, W-Ag, Mo-Ag, and W-Mo-Cu powders. The materials are first intimately blended in calculated proportions either in the dry state or in the form of an aqueous slurry. The blend can then be reduced in a reducing atmosphere, e.g., a H- or CO-containing atmosphere. The resulting powders give superior results in powder metallurgy application wherever good green strength is required for compaction to practical geometry. They are especially suitable for the molding of electrodes for use in electron discharge machining. (P.C.H.)

20835 ULTRAFINE DISPERSION-STRENGTHENING OF TUNGSTEN BY CHEMICAL COVAPOR DEPOSITION. Landingham, Richard L.; Casey, A. Wayne (Univ. of California, Livermore). J. Less-Common Metals; 26: No. 2, 173-98(Feb 1972).

A method of dispersion-strengthening tungsten, a refractory metal, with submicron (<10 Å) dispersoids of hafnium nitride, a stable ceramic, is described. Simultaneous deposition of the metal and the dispersoid is achieved by a chemical vapor deposition pro-

cess called covapor deposition. The tungsten and hafnium are covapor deposited by hydrogen reduction of their halides (WCl_6 and $HfCl_4$); the dispersoid is formed during deposition by the reaction of hafnium with NH_3 in the hydrogen gas. The microstructure of the tungsten matrix, either the large columnar grains typical of chemical vapor deposited tungsten or fine noncolumnar grains (<1 μm), can be controlled by varying the deposition parameters. It is also possible by varying these parameters to change the number, size, and spacing of the dispersoids. The deposits were heat treated at 1700°C for at least 1 h before hot microhardness values to 1400°C were determined. These values were then compared with hot microhardness values determined after heat treatment for 96 and 500 h at 1700°C. The microstructures of the deposits in these conditions were evaluated by thin film and scanning electron microscope techniques. The hot microhardness of the LRL dispersion-strengthened tungsten was superior to that of dispersion-strengthened tungstens prepared by other techniques. The possibilities of using this technique to improve the strength and creep resistance of other metals (e.g., nickel–chromium alloys for turbine blades) are also suggested. Parameters are given for the deposition of pure tungsten and hafnium nitride from their halides. (auth)

20836 UNDERSTANDING THE MECHANISMS OF ALUMINUM BRAZING. Terrill, J. R.; Cochran, C. N.; Stokes, J. J.; Haupin, W. E. (Alcoa Technical Center, Pittsburgh). Weld. J. (N. Y.); 50: No. 12, 833-9(Dec 1971).

In aluminum dip brazing, molten fluxes penetrate but do not dissolve oxide films on aluminum. Hydrogen fluoride, generated by the chemical reaction of moisture with fluoride salts in the flux bath, provides the openings in the oxide film for brazing filler alloy to flow under and lift oxide films. Some torch and furnace brazing fluxes provide the same mechanism. Most of these fluxes contain heavy metal chlorides and rely upon disruption of the oxide films and deposition of the heavy metal on the aluminum surface to facilitate wetting by the filler metal. Moisture in the brazing atmosphere influences the amount of flux necessary on a part for successful furnace brazing. A new process utilizes a controlled dry air atmosphere to effect brazing with minute amounts of furnace brazing flux. Successful fluxless brazing in vacuum or inert atmospheres depends on the presence of a promoter, either a metal or reactive gas. The key action of metal promotors in fluxless brazing is to reduce chemically the aluminum oxide films to permit alloy wetting. In addition, they must also scavenge remaining oxygen and moisture in the vacuum but these are not the key mechanisms. Many metals can fulfill the function of a braze promotor, but magnesium is the best. Certain halide vapors promote brazing through a double decomposition reaction with the aluminum films. Bromides and iodides of phosphorus and boron have been most successful. (auth)

20837 METALLURGIYA RENIYA. Trudy III Vsesoyuznogo Soveshchaniya po Probleme Reniya. Chast' 1. (Metallurgy of Rhenium. Proceedings of the 3rd All-Union Conference on the Problem of Rhenium. Part 1). Conference Held at Moscow, October 22–24, 1968. Savitskii, E. M.; Bibikova, V. I. (eds.). Moscow; Izdatel'stvo Nauka (1970). 136p. (CONF-681089-(Pt.1)).

The following topics are considered: sources of Re, the extension of Re production from Cu and Mo ores, and methods of obtaining high purity Re-containing products (extraction, ion exchange, rectification, electrolysis, etc.). Other methods of Re production include salt decomposition, reduction by hydrogen, electrochemical processes, and zone melting. (K.S.W.)

20838 RENII V NOVOI TEKHNIKE. Trudy III Vsesoyuznogo Soveshchaniya po Probleme Reniya. Chast' II. (Rhenium in New Equipment. Proceedings of the 3rd All-Union Conference on the Problem of Rhenium. Part 2). Conference Held in Moscow, October 22–24, 1968. Savitskii, E. M.; Tylkina, M. A. (eds.). Moscow; Izdatel'stvo Nauka (1970). 204p. (CONF-681089-(Pt.2)).

A description is given of the physicochemical interaction of Re with other elements, phase diagrams, and the properties of new alloys containing Re, e.g., Re–Mo, Re–W, Re–Ni, Re–Zr, Re–Sn, and the following ternary systems: Mo–Re–Hf, W–Re–Ir, Zr–Mo–Re, and Zr–W–Re. Diffusion characteristics and emission properties, work functions, catalytic properties, corrosion and electrochemical behavior, and the elasticity of Re and its alloys are considered in various papers. Thirteen papers are devoted to the practical utilization of Re alloys as cathodes, thermocouples, gas-discharge apparatus, electro-vacuum equipment, and electrical contacts in special devices. (K.S.W.)

20839 ELECTRODEPOSITION OF TERNARY ALLOYS OF COBALT–IRON–TUNGSTEN FROM THE PYROPHOSPHATE BATH. II. Sarojamma, M.; Ramachar, T. L. Metal Finish. J. (London); 17: No. 199, 184-8(Jul 1971).

Cathode potential results are reported and the variation of cathode efficiency with c.d. was studied for various conditions including the addition of agents such as thiourea and Na thiosulfate. Photomicrographs revealed bright but cracked surfaces. Some evidence of internal stress is also reported. X-ray studies reveal fcc and bcc structures at various levels of Co content. A mechanism of W deposition based on a consideration of the hydrogen overvoltage on W is proposed. (Metals Abstr.)

20840 ELECTROLYTIC PREPARATION OF VANADIUM FROM V_2C-TYPE CARBIDE. Lei, K. P. V.; Sullivan, T. A. Report of Investigation No. 7484. Washington, D. C.; Bureau of Mines (1971). 17p.

An electrochemical process was developed for the preparation of V from V_2C. Commercially available V_2C was used as the starting material. Vanadium was obtained by electrolysis of the V_2C in a $BaCl_2$–KCl–NaCl–VCl_2 electrolyte at 670°C using a He-atmosphere, molten-salt electrolytic cell. Vanadium products were recovered with purities as high as 99.5%. Current efficiencies of 87% and V recoveries of 84% were attained. The cathode products were amenable to electrorefining to high-purity V of 99.96% purity. (Metals Abstr.)

20841 STUDIES ON THE CARBON IMPREGNATION DURING HOT PRESSING IN WC–Co ALLOYS. Kubota, Haruo (Tokyo Tungsten Co. Ltd.); Hara, Akio. Funtai Oyobi Funmatsuyakin; 18: No. 3, 89-94(Sep 1971). (In Japanese).

Graphite is mainly used as the die material for the hot pressing of WC–Co alloys. Carbon impregnation to the sintered body which is caused by the contact of the powder (sintered body) and the graphite die was studied. The layer depth of carbon impregnation increased parabolically with an increase in time. However, it was assumed that the carbon impregnation which resulted in excess carbon precipitation did not occur during heating or at the initial stage of keeping time, but was assumed to begin after the sintering was completed. The layer depth of carbon impregnation increased with an increase of hot press temperature. The layer depth of carbon impregnation depended upon the property of the graphite used for the die. The hot press pressure did not have a definite relation to the layer depth of carbon impregnation, but was affected by the behavior of metal which was squeezed from the die and other factors. The metal which was squeezed from the die during hot pressing was mainly composed of cobalt and the WC content involved in it was by far less than that corresponding to the Co–WC eutectic. (auth) (Japan)

20842 ELECTRODEPOSITION OF TERNARY ALLOYS OF COBALT–IRON–TUNGSTEN FROM THE PYROPHOSPHATE BATH. I. Sarajamma, M.; Ramachar, T. L. Metal Finish. J. (London); 17: No. 198, 156-61(Jun 1971).

An investigation into the experimental conditions for depositing a ternary Co–Fe–W alloy from a bath containing ferric chloride, ammonium citrate, potassium pyrophosphate, cobalt chloride, and sodium tungstate is described. The performance of the bath was analyzed over a wide range of operating conditions. Recommendations are made for satisfactory deposits containing Co 20 to 62, Fe 13 to 58, and W 12 to 51%. (Metals Abstr.)

20843 METHOD FOR PRODUCING POROUS URANIUM. Asbury, Joseph J. (to United States Atomic Energy Commission). U. S. Patent 3,625,680. 7 Dec 1971. Filed 29 Oct 1968.

High-purity porous uranium articles are produced by preparing an admixture of particulate calcium oxide, magnesium metal, and uranium; pressing the mixture into a compact; sintering the compact in an inert atmosphere; and thereafter contacting the compact with acid solutions for removing the calcium oxide, magnesium, magnesium oxide, and uranium oxide. (Official Gazette)

20844 PREPARATION OF PLUTONIUM METAL. I. PREPARATION OF PLUTONIUM METAL BY LITHIUM REDUCTION OF AMMONIUM PLUTONIUM(IV) FLUORIDE. Naito, Keiji; Kojima, Masaru; Ouchi, Kinji; Yahata, Taneaki (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 11, 603-5(Nov 1971).

Ammonium plutonium fluorides, $PuF_4 \cdot 7/6NH_4F$ and $PuF_4 \cdot 2NH_4F$, were prepared by the addition of an acidic solution containing Pu(IV) to a mixed solution of NH_4F and HF. Anhydrous PuF_3 was obtained by thermal decomposition of the ammonium plutonium fluorides under reduced pressure or else in an inert gas flow. The anhydrous fluoride was then reduced with Li vapor to Pu metal. Cerium metal was prepared by the same method. (auth)

Properties, Structure, and Phase Studies

Refer also to abstracts 20237, 20521, 20675, 20685, 21562, 21564, 21566, 21568–21570, 21573, 21574, 21577, 21579, 21580, 21583, 22120, 22124, 22128, and 22339.

20845 (AD-731712) ULTRASONIC STUDY OF THE BETA-TO-OMEGA PHASE IN Zr–Nb ALLOYS. Goasdoue, Claude; Ho, Paul S.; Sass, Stephen L. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 27 Sep 1971. Contract N00014-67-A-0077-0012. 22p. (MSC–1648). NTIS.

Elastic constant, ultrasonic attenuation, and x-ray measurements were made as a function of temperature on Zr–Nb single crystals in order to study the mechanism of the Beta to Omega phase transformation. In the Zr–20 wt % Nb alloy C_{44} decreased with decreasing temperature starting at 330 to 340°K reaching a minimum at 160°K, while both C′ and C_{11} showed a positive deviation from linear quasiharmonic behavior starting at 250 to 280°K. These observations were reversible with temperature. X-ray measurements indicated that little if any Omega phase was present in the 20 wt % Nb alloy at 300°K and that upon cooling to 89°K a small amount of Omega was formed. It is suggested that the positive deviation C_{11} and C′ from the extrapolated values based on quasiharmonic theory is due to the presence of the Omega phase and that the onset of the Beta to Omega phase is indicated by the first sign of deviation from linearity. The negative deviation of C_{44} from quasiharmonic behavior is attributed to a softening of the bcc structure which is a precursor to the actual transformation. The observations on the Zr–25 wt % Nb alloy were in general agreement with these suggestions. In the Zr–30 wt % Nb alloy the x-ray results indicated that no Omega phase is present over the temperature range 89 to 300°K and C_{11}, C′ and C_{44} all showed a normal linear variation with temperature, in agreement with the above suggestions. (auth) (USGRDR)

20846 (AED-CONF-71-100-26) PROGRESS IN ZIRCALOY-4 CANNING TECHNOLOGY FOR PWR FUEL. Stehle, H. (Siemens A.G., Erlangen (West Germany)). May 1971. 21p. (CONF-710901–524). Dep. NTIS (U. S. Sales Only).

From fourth international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Progress is reported in Zircaloy-4 canning technology for PWR fuel in the following areas: investigation of biaxial mechanical properties (bursting, creep); improvement and simplification of surface treatment; and welding in pressurized atmosphere. (D.H.M.)

20847 (BMI–1920) PROGRESS ON LMFBR CLADDING, STRUCTURAL, AND COMPONENT MATERIALS STUDIES DURING JULY–SEPTEMBER 1971. Quarterly Report. Keller, Donald L. (Battelle Columbus Labs., Ohio). Oct 1971. Contract W-7405-eng-92. 14p. Dep. NTIS.

A program is being directed toward developing mechanical-property design data for reactor materials at temperatures above 800°F. Low-cycle-fatigue tests were conducted on Type 304 stainless steel to conclude work on this material; these were incremental step tests run at 1000°F at two strain rates. In addition, specimens of both Type 304 stainless steel and Incoloy Alloy 800 were run at 70°F under constant-amplitude continuous cycling. The purpose of these tests was to develop cyclically stable stress-strain data for comparison with prior data from incremental tests run at room temperature. Testing on Type 316 stainless steel was initiated. Four constant-amplitude, continuous-cycling tests were run at both 800 and 900°F. (auth)

20848 (CEA-R–4230) CRYSTALLOGRAPHIC STUDY OF THE $\beta \rightarrow \alpha$ ALLOTROPIC TRANSFORMATION IN Zr, WEAKLY ALLOYED WITH Pu (TEXTURE CHAMBER PROJECT). Cornet, Jean-Francois (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov. 1971. 150p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Lyon Univ., France.

Zr alloys containing small quantities of plutonium (0.3 to 3 percent by weight) exhibit a segregation phenomenon after being heat treated in the β phase (body centered) and then slowly cooled. Crystallographic examination of the two types of sample revealed that the orientation relations of the martensitic $\beta \rightarrow \alpha$ transformation of Zr are not affected by the presence of solute. The segregations are needle shaped and orientated along one of the 111 axes of the high temperature cubic lattice. The fact that no more than four needle directions were found in an original β phase grain confirmed this result. Crystallographic techniques developed in this study led to the conception of an apparatus for texture analysis which enables the stereographic projection of the pole figure studied to be reconstructed directly on photographic papers. (France)

20849 (CONF-710938) ELEVENTH INTERNATIONAL THERMAL CONDUCTIVITY CONFERENCE, ALBUQUERQUE, NEW MEXICO, SEPTEMBER 28–OCTOBER 1, 1971. (Sandia Labs., Albuquerque, N. Mex. Los Alamos Scientific Lab., N. Mex. New Mexico Univ., Albuquerque). 175p. Dep. NTIS.

Summaries are included for eighty-four of the papers presented. Sixteen of the papers are title listed in NSA. (D.H.M.)

For abstracts of individual papers see: 20220, 20681–20688, 20850–20853, and 20940–20942.

20850 (CONF-710938–, pp 1-2) THERMOPHYSICAL PROPERTIES OF AFML–AGARD TUNGSTEN. Taylor, R. E. (Purdue Univ., Lafayette, Ind.). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20851 (CONF-710938–, pp 3-4) THERMAL DIFFUSIVITY OF MOLYBDENUM AND TUNGSTEN BETWEEN 20°C AND 2000°C. Johnson, K. W. R.; Kerrisk, Jerry F. (Los Alamos Scientific Lab., N. Mex.). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20852 (CONF-710938–, pp 16-17) THERMAL CONDUCTIVITY AND LORENZ NUMBER OF A LIQUID INDIUM–GALLIUM ALLOY. Duggin, M. J. (National Standards Lab., Sydney (Australia). Div. of Physics). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20853 (CONF-710938–, pp 115) ELECTRICAL RESISTIVITY OF HIGH-PURITY TUNGSTEN FROM 1100 TO 2500 K. Williams, R. K.; Fulkerson, W. (Oak Ridge National Lab., Tenn.). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20854 (GEAP–13736) CHARACTERIZATION OF COLD-WORKED TUBING OF TYPES-304H AND -316H STAINLESS STEEL. Lauritzen, T.; Busboom, H. J. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Aug 1971. Contract AT(04-3)-189. 58p. Dep. NTIS.

Eight lots of cold-worked austenitic stainless steel tubing (5G430G) were characterized. Tubing quality was well within the ordering specification, and hence is considered "nuclear quality" for use in fabrication of fuel pins and tensile test specimens destined for EBR-II reactor experiments. (auth)

20855 (NP–19188) DISLOCATION ARRANGEMENTS IN DEFORMED ALPHA–ZIRCONIUM. Bedford, A. J. (Adelaide Univ. (Australia). Dept. of Chemical Engineering). Dec 1970. 296p. Dep. NTIS (U. S. Sales Only).

Thesis.

Dislocation structures resulting from the deformation of relatively pure polycrystalline alpha-zirconium were made in an attempt to explain some of the yielding phenomena associated with Zr and its alloys. Specimens were examined at $\sim 10^{-5}$ torr at temperatures between 0 and 600°C. Complete analyses were made of the hexagonal networks of dislocations which formed by straining about 500°C or by straining at room temperature followed by recovery between 400 and 600°C. These networks were found to be non-coplanar. Mechanisms to explain their formation are proposed. The production of thin Zr foils suitable for study by transmission electron microscopy was examined in detail and particular reference made to hydride precipitation during foil preparation. Crystallographic techniques for use with the hcp lattice were examined and simplified procedures for carrying and tilting experiments in the electron microscope were developed. (130 references) (Australia)

20856 (NYO–4078-6) BRITTLE-TO-DUCTILE TRANSITION INDUCED BY ENVIRONMENTAL PRESSURE. Avitzur, Betzalel (Lehigh Univ., Bethlehem, Pa. Dept. of Metallurgy and Materials Science); Avitzur, Boaz (Watervliet Arsenal, N. Y. Benet R and E Labs.). [1970]. 11p. (CONF-701062-1). Dep. NTIS.

From National conference on fluid power; Chicago, Ill. (14 Oct 1970).

The effect of environmental pressure on ductility is considered in conjunction with investigation of the effect of damage due to the presence of inclusions and voids as a factor in the behavior of deforming metals. The transition from brittle behavior to ductile flow during metal forming under environmental pressure is discussed. Analytical predictions of the transition are compared with experimental work utilizing liquid environmental pressure. Both the morphology and the gross plastic flow are covered. Models with artificial inclusions and real materials are investi-

gated. Porous materials, e.g., tungsten, are deformed at room temperature. Other materials, including fiber-reinforced metals, powder compacts, and conventional high strength steels, are discussed. (auth)

20857 (SC-T-722466) SUPERPLASTICITY OF ALPHA URANIUM DURING RECRYSTALLIZATION, AS REVEALED BY ANISOTHERMAL CREEP. Collot, Jean; Cizeron, Georges. Translated for Sandia Labs., Albuquerque, N. Mex., from Comp. Rend., Ser. C; 272: 520-3(1971). 7p. Dep. NTIS.

A new technique for measuring anisothermal creep under constant load was used with strongly rolled U of electrolytic purity to reveal superplastic behavior due to the progressive evolution of a duplex structure in the course of recrystallization. (auth)

20858 (SC-T-722468) DIFFUSION, PERMEABILITY, AND SOLUBILITY OF HYDROGEN AND DEUTERIUM IN Pd–Ni ALLOYS. Gol'tsov, V. A.; Demin, V. B.; Gel'd, P. V.; Kagan, G. E. Translated for Sandia Labs., Albuquerque, N. Mex., from Fiz.-Khim. Mekh. Mater.; 7: No. 3, 56-60(1971). 8p. Dep. NTIS.

Studies on the solubility, diffusion, and permeability of D and H in Pd–Ni alloys showed that the solubility decreased with increasing temperature in both pure Pd (exothermic occluder) and the 9.55 at % Ni alloys, whereas in the 26.8 at. % Ni alloy (endothermic occluder) the solubility increased with rising temperature (up to 550°C). The permeability and diffusion coefficient for H (D) in Pd–Ni alloys at 9.55 and 26.8 at. % Ni were found to increase anomalously at temperatures above 600 and 550°C, whereas the solubility was found to fall off. These effects are ascribed to a reduction in the degree of order in the alloys at these temperatures. The introduction of 9.55 and 26.8 at. % Ni into Pd led to a reduction by factors of 1.7 and 7.0, respectively, in the solubility at temperatures between 300 and 550 to 600°C. The diffusion coefficients were also reduced by the introduction of 9.55 at. % of Ni to Pd. However, additional alloying with 17 at. % Ni had practically no effect on the diffusion coefficients at these temperatures. (P.C.H.)

20859 (TID-25917) PHOTOELASTIC DETERMINATION OF STRESSES IN ASA B16.9 TEES. Johnson, R. L. (Westinghouse Research Labs., Pittsburg, Pa.). Sep 1971. 106p. Dep. NTIS. For Oak Ridge National Lab., Tenn.

Three-dimensional photoelastic tests were performed on accurate, half-scale models of four ASA B16.9 tees. The $12 \times 12 \times 12$ schedule 80 and $12 \times 12 \times 6$ schedule 40 models were subjected to out-of-plane bending of the branch. The $12 \times 12 \times 12$ schedule 160 and $12 \times 12 \times 6$ schedule 160 models were tested under internal pressure. The largest stress due to bending was a compression of -3.03 times the nominal stress in the branch. The maximum stress due to internal pressure was a tension 14.3 times the pressure. The stress distributions through the wall thickness at points of maximum stress were nearly linear for the bending tests, but were quite nonlinear for the pressure tests. (auth)

20860 (UCRL-51169) STRAIN GAGING NICKEL-PLATED URANIUM. Dittbenner, Gerald R. (California Univ., Livermore. Lawrence Livermore Lab.). 5 Jan 1972. Contract W-7405-eng-48. 7p. Dep. NTIS.

Strain-gage data and techniques used on D-38 test beams electroplated with nickel and gold and tested at 75 and 400°F are presented. The strain gages provide accurate measurements when bonded to the nickel-plated uranium surface. (auth)

20861 FIZIKO-KHIMICHESKIE OSNOVY PROIZVODSTVA STALI. (Physicochemical Bases of Steel Production). Reports of Symposium on Metallurgy and Metallography, Moscow, May 14–18, 1968. Part I. Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). 583p. (CONF-680564-(Pt.1)).

Part I contains 122 papers on steel and related alloys, and is subdivided according to the following classification: thermodynamics and kinetics of metallurgical processes, nonmetallic occlusions and problems of slag formation, the use of oxygen in ferrous metallurgy, alloy properties and crystallization problems, and the use of vacuum in electroslag remelting. A separate abstract was prepared for each of 10 papers. A similar quantity of material which was also generated by the symposium has been published as Part II, and the abstracts appeared in Volume 25 (1971) of NSA. (K.S.W.)

For abstracts of individual papers see: 20702–20705, 20777, and 20862–20866.

20862 THEORY OF REDUCTION OF METALS. Kulikov, I. S. pp 55-8 of Fiziko-Khimicheskie Osnovy Proizvodstva Stali. /Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The activities of reducing metals were found to be functions of the oxidizing potentials. This principle was demonstrated with examples of the reduction of Fe at 1,600°C by a series of metals, which included Th, Zr, Ca, Ti, Al, and Be. Satisfactory agreement between the calculations and experimental data was obtained in the majority of cases. (tr-auth)

20863 ACTION OF NITROGEN ON NICKEL ALLOYS. Fedorchenko, V. I.; Averin, V. V.; Samarin, A. M. pp 64-8 of Fiziko-Khimicheskie Osnovy Proizvodstva Stali. /Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The kinetics of absorption and release of nitrogen were studied in the alloys Ni–Cr, Ni–Mo, and Ni–W at N pressures from 0.3 to 1 atm. The rate of these processes may be described by a first order equation; the rate constant is independent of the N pressure in the gaseous phase. The effects of Cr, Mo, and W on the rate constants were derived from their influence on the N diffusion coefficient and the viscosity of the alloys. The solubility of N in pure liquid Ni was a square root function of the N pressure over the temperature range 1,500 to 1,700°C. (tr-auth)

20864 EFFECT OF NITROGEN ON LIQUID NICKEL ALLOYS. Stomakhin, A. Ya.; Fridman, A. G.; Tripolitov, A. I.; (and others). pp 68-73 of Fiziko-Khimicheskie Osnovy Proizvodstva Stali. /Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The solubility of N and the formation of nitrides in liquid binary Ni alloys were investigated where the second metal was Cr, Mo, W, Al, Ce, Ti, or Zr. The adherence of the N–metal solutions to Sivert's law is discussed. The possible existence of Ti nitrides in certain Ni alloys was examined. Thermodynamic calculations supported the extrapolation of experimental data on nitrides over greater temperature intervals and concentrations of the nitride-forming elements. (tr-auth)

20865 EFFECTS OF ALLOYING Si, Nb, V, Ti, Zr, AND Cr AND OF THE METHOD OF MELTING ON THE STRUCTURE AND MAGNETIC PROPERTIES OF Fe–Ni–Co–Al–Cu ALLOYS. Kuznetsov, V. M.; Lobyntsev, E. S.; Samarin, A. M. pp 96-9 of Fiziko-Khimicheskie Osnovy Proizvodstva Stali. /Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

Studies were made on the effects of alloying with 0.1 to 25% Nb, 0.2 to 1.0% V, 0.5 to 6.0% Cr, 0.1 to 1.5% Si, 0.1 to 1.5% Mn, 0.2 to 1.7% Ti, and 0.1 to 3.0% Zr on the high-temperature disintegration of the solid solution, on the temperature limitations of high coercive $\alpha \rightarrow (\alpha - \alpha')$-decay, and on magnetic properties of samples which had been fused in argon and in air atmospheres. (tr-auth)

20866 SURFACE PROPERTIES OF INTERPHASE DIVISION BOUNDARIES OF LIQUID IRON WITH ZIRCONIUM-CONTAINING OXIDE MELTS. Samarin, A. M.; Mikiashvili, Sh. M.; Dzhincharadze, T. I.; Gogiberidze, Yu. M. pp 248-51 of Fiziko-Khimicheskie Osnovy Proizvodstva Stali. /Chernyshev, A. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Symposium on metallurgy and metallography; Moscow, USSR (14 May 1968).

The surface tension and work of adhesion to an interphase boundary were measured by the sessile drop method in liquid Fe in contact with the system ZrO_2–MnO–SiO_2–Al_2O_3. Such an oxide system may be formed in liquid steel by deoxidation of the steel by means of Zr-containing alloys. The concentration region in the composition of reduction products of steel was established by Zr-containing alloys capable of coalescing and removing them from a liquid metal. (tr-auth)

20867 STUDIES ON THE CONSTRUCTION OF AN OXIDE MEASURING CELL FOR MOLTEN SODIUM. Reetz, T.; Ullmann, H.; Betzl, K. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 14: No. 7-8, 257-60(Jul-Aug 1971). (In German).

Theoretical and experimental investigations were performed on the construction and properties of an oxide measuring cell based on the solid electrolyte principle. The cell consists of a solid electrolyte tablet (ThO_2–$YO_{1.5}$ with 20 mole % of $YO_{1.5}$) soldered into a metallic tube. Air was selected as the reference system. The dimensions of the solid electrolyte were optimized. Values of 96 to 97% of the theoretical cell potential have been found during measurements in sodium saturated with oxide. Mechanical strength of the arrangement and its stability to changes in temperature are sufficient, but corrosion resistance of the electrolyte is not yet sufficient for technical purposes. (auth)

20868 NOVEL IRON–CHROMIUM–BERYLLIUM ALLOY SYSTEM. Robertshaw, Fred C.; Perkins, Roger J. (to United States Atomic Energy Commission). U. S. Patent 3,625,675. 7 Dec 1971. Filed 1 Apr 1969.

The development of selected iron–beryllium–chromium alloy systems containing minor additions of at least one strength-inducing additive selected from the group consisting of tungsten, niobium, carbon, and yttrium is described. The alloys are characterized by high strength from room temperature to temperatures up to at least 550°C and by a stable, body-centered, cubic structure over the full range of temperature from room temperature up to the melting point. (Official Gazette)

20869 TRANSPORT PROPERTIES OF MOLTEN ALLOYS IN THE PRE-FREEZING RANGE. Petrescu, N. Cercet. Met.; 11: 1119-26(1970). (In Rumanian).

The results of self-diffusion- and viscosity-coefficient measurements in the In–Sb alloy system are presented. The particular variations of these properties in the pre-freezing range were estimated in relation to the alloy structure in the solidified state. (Metals Abstr.)

20870 TRANSPORT PROPERTIES THROUGH THE LIQUID-STATE MISCIBILITY GAP OF ALLOYS. Zamirca, S.; Ganovici, I.; Ganovici, Lucia. Cercet. Met.; 11: 1107-18(1970). (In Rumanian).

Viscosity and diffusivity data obtained with alloys of the Al–In and Al–In–Ag system characterized by miscibility gaps were established. The polytherms revealed structural changes in the liquid in the premiscibility phase. The importance of these results for the segregation and crystallization processes is discussed. (Metals Abstr.)

20871 AGING CHARACTERISTICS OF LOW-ALLOY MOLYBDENUM-BASE ALLOYS. Zueva, I. B.; Mezhenny, Yu. O.; Skakov, Yu. A. Izv. Vyssh. Uchеb. Zaved., Chern. Met.; No. 7, 119-21(1971). (In Russian).

Aging processes taking place in Mo–Zr–C alloys were studied by x-ray diffraction. The changes in lattice spacing associated with the presence of interstitial impurities in solid solution were determined in relation to the distance from the sample surface and the annealing temperature. Decomposition processes resulting in the precipitation of the carbide phases ZrC and Mo_2C only occurred in the surface layers of the alloy; in these layers they impeded recrystallization. (Metals Abstr.)

20872 PHASE CHANGES IN METAL SURFACES DURING EROSION BY SPARK OR OTHER HIGH-ENERGY TREATMENT. Krainer, E.; Robitsch, J. (Gebr. Bohler and Co., A. G., Kapfenberg, Austria). Metall; 25: No. 12, 1361-4(Dec 1971). (In German).

Surface treatment processes which attack very limited local areas at high energy densities cause thermal shocks of short duration, and may lead to the formation of metastable phases. Such changes include a new cobalt phase and a stabilized cubic tungsten carbide. Several attempts in this direction with Fe, Ni, and Co are also reported, but only the formation of metastable austenite in steel was detected. (tr-auth)

20873 ELECTROCHEMICAL SEPARATION AND STUDY OF PHASES IN A TITANIUM ALLOY. Trukhanova, Z. S.; Shakhanova, G. V.; Sokolova, M. I. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 6, 853-5(Jun 1971).

Translated from Zavod. Lab.; 37: No. 6, 666-7(Jun 1971).

The effects of the electrolyte and the conditions of electrolysis on the selectivity and on the completeness of the extraction of the β phase in the alloy VT-3 (6.04% Al, 2.45% Mo, 1.9% Cr, 0.40% Fe, bas Ti) were studied. The effect of the form of heat treatment on the distribution of the alloying elements between the α and β phases was also studied. (D.H.M.)

20874 DIFFUSIVE AND THERMODYNAMIC PROPERTIES OF γ-PHASE OF URANIUM–NIOBIUM ALLOYS. Fedorov, G. B.; Smirnov, E. A.; Gusev, V. N. At. Energ. (USSR); 32: No. 1, 11-14(Jan 1972). (In Russian).

^{238}U and ^{95}Nb diffusion in uranium–niobium alloys was studied by the sectioning method. The measurements were carried out within the temperature range of 930 to 1900°C. Niobium alloying of uranium considerably reduces the coefficients of diffusion. On the basis of the data obtained in this work and earlier data, the coefficients isolines and the isolines of the activation energies of diffusion in the uranium–niobium–zirconium system at 1100°C were drawn. Thermodynamic properties of the uranium–niobium system alloys were examined by measuring the electromotive force of the elements in the temperature range 750 to 900°C, using as one of the electrodes the uranium alloys with Nb contents of 5, 11.7, 20, 32, 47, 72, and 87%. (K.F.W.)

20875 PHASE DIAGRAM AND PROPERTIES OF ALLOYS OF THE SYSTEM Nd–Bi. Kobzenko, G. F.; Chernogorenko, V. B.; Fedorchenko, V. P. (Inst. of Problems in Materials Science, Kiev. Inst. of Physics of Metals, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 8, 1275-7(Aug 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 8, 1438-40(Aug 1971).

The phase diagram for the system Nd–Bi was constructed from the results of differential thermal, metallographic, and x-ray phase analyses, and showed that the alloys undergo six nonvariant transformations: at 300°C-$\alpha NdBi_2$ + L $\rightleftharpoons$ αBi; at 820°C-βNd $\rightleftharpoons$ αNd + αNd_3Bi; 900°C-L_e (92.2 at.% Nd) $\rightleftharpoons$ βNd + αNd_3Bi; 1150°C-αNd_4Bi_3 + L $\rightleftharpoons$ Nd_3Bi; 1600°C-αNdBi + L $\rightleftharpoons$ $NdBi_2$; and 1750°C-αNdBi + L $\rightleftharpoons$ Nd_4Bi_3. The metallographic and phase analyses revealed that all the alloys are one-phase in character or are mechanical mixtures of phases. The phases observed were solid solutions of Bi, Nd, and Nd_3Bi, Nd_4Bi_3, NdBi, and $NdBi_2$. The values of the Hall coefficient changed widely with composition from 7.1×10^{-4} to -3.8 cm$^3 \times$ cm^{-1}. Only NdBi at 300 to 600°C displayed semiconductor conductivity. (P.C.H.)

20876 PYROPHORIC PROPERTIES OF METAL POWDERS AND DUSTS. Sliwa, Antoni. Rudy Metale Niezelaz.; 16: No. 11, 559-64(Nov 1971). (In Polish).

Some of the more important relationships and parameters governing self-ignition and explosion of metal powders and dusts are described. Values of characteristic limiting explosion concentrations, initiation temperatures, and energies as well as pressures and rates of explosion pressure rise are given for metal powders used in engineering. (auth)

20877 TIMELY PHYSICAL PROBLEMS OF SOME NON-FERROUS METALS. Stefan, Mihaly (Csepel Metallurgical Works, Hungary). Magy. Fiz. Foly.; 19: No. 5, 451-63(1971). (In Hungarian).

Recent achievements of investigations carried out in Hungarian research institutes on the structure, preparation, and application of nonferrous metals, primarily Cu and Mo, are reviewed. At the Csepel Metallurgical Works oxygen-free, 99.99% pure Cu is fabricated at an industrial scale; the product has a conductivity of 59.4 to 59.65 ohm mm^2/m. Mo presents many excellent properties, such as high melting point, high modulus of elasticity and a low coefficient of thermal expansion; unfortunately, it oxidizes rapidly at temperatures above 650°C and can be protected only by applying a silicide base coating. Various types of Mo intermediates, such as foils, sheets, and wire have been fabricated in Hungary; their value increased 20 to 30 fold with respect to that of the original powder. Current studies include comparison of products fabricated by powder metallurgy and electron beam melting, improvement of the ductility of the product by microalloying after high-temperature soaking or welding. Polymorphic metals used for the preparation of superconductors, such as Ti, Zr, Hf, Th, U, Tl, Sn, La, and Hg were also investigated to determine the effect of irradiation by high-energy elementary particles on the allotropic transformation process. (TTT)

20878 STRENGTHENING ON AGING MOLYBDENUM ALLOYS CONTAINING TITANIUM AND ZIRCONIUM CARBIDES. Zakharov, A. M.; Novikov, I. I.; Parshikov, V. G.; Portnoi, V. K. (Moscow Inst. of Steel and Alloys). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 5-6, 494-6(May-Jun 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 6, 48-50(Jun 1971).

Hardness measurements were used to investigate the strengthening that occurs on aging at 900 to 1500°C in molybdenum alloys belonging to the systems Mo–Ti–C, Mo–Zr–C, and Mo–Ti–Zr–C quenched from 2100°C. Electron-microscopic analysis was used to determine the alloys' phase composition in the later stages of aging. On aging quenched alloys for 10 to 20 h, the molybdenum solution precipitated those phases that should exist in the alloys according to the equilibrium diagrams of the system Mo–Ti–C, Mo–Zr–C, and Mo–Ti–Zr–C. Maximum hardness was attained in the alloys on aging at 1200 to 1300°C (0.5 to 0.55 T_{mp}) for 2 to 4 h. The carbide ZrC strengthened the alloys investigated to the greatest extent, and the carbides (Ti, Zr)C and TiC strengthened them least. The carbide Mo_2C reduced the strengthening effect on aging, and hence its presence in the alloys was undesirable. (auth)

20879 PLASTICITY AND STRENGTH OF NEODYMIUM. Solenov, V. M.; Sokolov, L. D.; Skudnov, V. A.; Gladkikh, A. N. (Gorky Polytechnic Inst., USSR). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 5-6, 519-22(May-Jun 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 6, 66-9(Jun 1971).

Plastic deformation was studied on annealed Nd specimens with an initial average grain size of 0.02 mm. The results showed that plasticity increased and strength decreased at $T > 0.5\ T_m$ (T_m = melting point in °K). The influence of deformation rate on both indexes became stronger as the temperature was raised over a definite range. In comparison studies with Zn, the results indicated that the rate of relaxation processes is substantially higher in Zn than in Nd. (P.C.H.)

20880 EFFECT OF THE RATE AND TEMPERATURE OF DEFORMATION ON THE PROPERTIES AND STRUCTURE OF THE Mo–0.5 PERCENT Ti ALLOY. Vitorskii, Ya. M.; Gal'chinskii, F. K.; Kaverina, S. N.; (and others) (Inst. of Metal Physics, Kiev). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 5-6, 497-500(May-Jun 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 6, 50-3(Jun 1971).

Studies were made on the effects of deformation rate and temperature on the ductility, properties, and structure of the Mo–0.5% Ti alloy. The results showed that high-speed deformation substantially raised the ductility in the working process. Satisfactory plastic properties at room temperature were attained only in rods that had been subjected to a degree of deformation at least 70%, i.e., in rods with a well-defined fibrous structure. In specimens reduced at 600 to 1200°C, it was found that at both high and low rates, a forging cross and stagnant zones were clearly visible in the macrostructures of the worked specimens. It was concluded that in order to secure the optimum combination of strength and ductility in forged and extruded components of the Mo–0.5% Ti alloy, it is essential to subject the billets to at least 70% deformation so as to produce a cellular structure at a temperature below the recrystallization temperature under conditions that exclude the thermal effect during working. (P.C.H.)

20881 TECHNOLOGICAL AND MECHANICAL PROPERTIES OF SOME TUNGSTEN ALLOYS. Klypin, B. A.; Manegin, Yu. V.; Markin, V. G.; Fedorov, Yu. K. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 5-6, 490-3(May-Jun 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 6, 44-7(Jun 1971).

Extruded, rolled, and forged rods have been produced from the vacuum-melted tungsten alloys: W–0.5 Ti, W–10 Mo–0.5 Ti, and W–0.5 Ti–0.1 Zr. To obtain good-quality rods from these tungsten alloys, an extension >4 must be used in extrusion. The introduction of 10% Mo into the W–0.5 Ti alloy raised its strength at temperatures up to 2000°C and also improved the macrostructure and quality of the ingot, while maintaining adequate technological ductility. The addition of 0.1% Zr to the W–0.5 Ti alloy sharply raised its recrystallization temperature and strengthened the alloy at 1500 to 1700°C, though working the alloy became more difficult. (auth)

20882 RECRYSTALLIZATION OF ALUMINUM AND ALUMINUM ALLOY FOILS. Drits, M. E.; Kadaner, E. S.; Toropova, L. S. (Inst. of Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 5-6, 399-401(May-Jun 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 5, 49-51(May 1971).

The effects of Cu, Zn, Ag, Mg, Ce, Nd, misch metal, Mn, Cr, Ti, and Zr on the recrystallization temperature of aluminum foil with a thickness of 20 μ were investigated. Recrystallization processes were inhibited most effectively by Zr, Mn, Ti, and Cr. Recrystallization occurred considerably more rapidly in foil than in bulk material of the same composition, which was due to the characteristics of the fine structure. (auth)

20883 HEAT-RESISTING WELDABLE ALLOY KhN57MTVYu (EP590). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 5-6, 387-9(May-Jun 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 5, 39-42(May 1971).

A new weldable heat-resisting Ni-base alloy has been developed — KhN57MTVYu with the following chemical composition: 17 to 19% Cr, 8 to 10% Mo, 1.5 to 2.5% W, 8 to 10% Fe, 2.2 to 2.8% Ti, 1 to 1.5% Al, ≤0.07% C, ≤0.5% Si, ≤0.5% Mn, ≤0.01% S, ≤0.015% P, ≤0.005% B, ≤0.01% Ce, and the remainder Ni. The mechanical and physical properties of the alloy are tabulated and discussed. The alloy can be welded by all methods ordinarily used for heat-resisting alloys. To remove welding stresses the alloy is heated rapidly to quenching temperature. (P.C.H.)

20884 EFFECT OF ALLOYING WITH REFRACTORY METALS ON THE STRENGTH AND RESISTANCE TO OXIDATION OF PLATINUM. Vasil'eva, E. V.; Zakharova, M. I.; Lazareva, I. Yu. (Inst. of Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 5-6, 372-5(May-Jun 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 5, 25-9(May 1971).

Alloying of platinum with refractory metals (within the limits of a solid solution) substantially increased the strength at standard and high temperature under conditions of short-term and long-term stress. The time to failure at 1300°C under stress $\sigma = 1$ kg/mm^2 for alloys of platinum with 5% Re and 4.7% Ta was almost double that of Pt + 7% Rh and was only slightly inferior to that of Pt + 10% Rh. The results from short-term and long-term tests at 1300 and 1500°C were in agreement with the homologous diffusion rule. The anomalous properties of alloys with titanium under the given conditions are explained by the nonvacancy diffusion mechanism of titanium. It was possible to formulate binary alloys of platinum with refractory base metals with a heat resistance at 1300 to 1500° that was several times higher than that of platinum. The best alloys were those with 4.7% Ta, 1 and 5% W, 1.3% Ti, and 0.47% Nb, which could be further strengthened by using either additional alloying or other methods, depending on the application. The oxidation of unalloyed platinum and its alloys with rhenium was characterized by weight losses, due to the formation of platinum–rhenium oxides that are volatile at 1300°; the weight increased for alloys with niobium, tungsten, tantalum, and titanium, due to the formation of nonvolatile oxides. X-ray diffraction analysis showed the preferential oxidation of the alloying elements at 1300° — niobium, tantalum, tungsten, and titanium — which was due to their high activity with respect to oxygen as compared with platinum. The amount of oxide increased with time. (auth)

20885 STRUCTURE OF MAGNESIUM ALLOYS WITH ZINC AND RARE EARTH METALS. Petsol'd, F.; Beyer, B. (Scientific-Research Inst. of Ferrous Metals, Freiberg, Ger.). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 5-6, 369-71(May-Jun 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 5, 22-4(May 1971).

In alloys of Mg with misch metal the rare earth metals cerium, lanthanum, neodymium, and praseodymium were found in the solid solution rich in Mg and in the heterogeneous phase Mg_9MM. This phase was formed with Mg of the binary system with a limited solubility in the solid state. In ternary alloys of the Mg–Zn–MM type a ternary phase occurred, corresponding to the formula $Mg_{20}Zn_5\Sigma REM_2$. (auth)

20886 CRITICAL HEAT FLUXES DURING Na–K EUTECTIC BOILING UNDER FREE CONVECTION CONDITIONS. Subbotin, V. I.; Sorokin, D. N.; Kudryavtsev, A. P.; Brigutsa, V. I.; Zhirova, R. I. At. Energ. (USSR); 32: No. 1, 62-3(Jan 1972). (In Russian).

Critical heat fluxes were studied during boiling of the eutectic alloy: Na/K = 22/78, both under vapor pressure and under Ar, and at pressures of from 0.012 to 0.45 kg/cm^2. It was found that for the NaK alloy, as for nonmetallic liquids, the dependence of the critical heat fluxes on pressure exhibits a different character than pure Na or pure K, and the critical heat flux is generally substantially higher than that of pure components. (K.S.W.)

20887 SURFACE AND INTERFACIAL ENERGIES IN SYSTEMS OF CERTAIN REFRACTORY METAL MONOCARBIDES WITH LIQUID COBALT. Warren, R.; Waldron, M. B. (Univ. of Surrey, Guildford, Eng.). Nature (London) Phys. Sci.; 235: No. 56, 73-4(24 Jan 1972).

It was found that the multiphase equilibrium technique for the determination of surface energies of solids (J. Less Common Metals 20: 93(1970)) is applicable to the measurement of the surface and interfacial energies of certain carbide–liquid Co systems, and results are given for the systems TiC, HfC, VC and NbC with liquid Co. The method was previously applied to measurement of the surface energies of UO_2 and UC, and involves measurement of certain equilibrium interphase angles, that are directly related to the energies of the interfaces forming them. Applicability of the method depends on the existence of a liquid that readily forms the relevant equilibrium angles but does not react chemically with the solid. The relative values of the interfacial energies have a considerable influence on the liquid phase. (UK)

20888 ELECTRON MICROSCOPY OF ADJUSTED URANIUM. Baker, C.; Lobb, R. C. (Central Electricity Generating Board, Berkeley, Eng.). Jernkontorets Ann.; 155: No. 8, 415-21(1971). (CONF-710439-3).

From second international conference on high-voltage electron microscopy; Stockholm, Sweden (14 Apr 1971).

The effect of thermal cycling on the distribution of intra-

granular UAl_2 precipitates in uranium containing 200 to 300 ppM iron and 500 to 1200 ppM aluminum has been studied in a Hitachi electron microscope at 1000 kV. Two distinct types of precipitates, 30 to 50 nm and 5 to 7.5 nm in diameter, respectively, were found in disk specimens taken from commercial fuel elements for Magnox reactors. After 1000 cycles between 400 and 600°C the small precipitates had vanished while the mean diameter of the large precipitates increased. The effect of thermal cycling is compared with isothermal annealing and it was found that the cycling is instrumental in the precipitate becoming coarser. (Sweden)

20889 LOCAL X-RAY SPECTRAL ANALYSIS OF CHEMICAL MICROHETEROGENEITY IN CAST ALLOYS. Nedyukha, I. M. (Inst. of Casting Problems, Kiev). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 6, 858-60(Jun 1971).

Translated from Zavod. Lab.; 37: No. 6, 669-72(Jun 1971).

Microscopic dendritic inhomogeneity affects the structure and properties of cast alloys. A method of determining microinhomogeneities by spectral intensity analysis is described. A mean spectral intensity is determined for the test sample the value of which is compared with that of an alloy of similar nominal composition. (J.R.D.)

20890 DECOMPOSITION PRESSURE, CONGRUENT MELTING POINT, AND ELECTRICAL RESISTIVITY OF CERIUM NITRIDE. O'Dell, K. D.; Hensley, E. B. (Univ. of Missouri, Columbia). J. Phys. Chem. Solids; 33: No. 2, 443-9(Feb 1972).

The melting point of CeN in nitrogen was determined at pressures between 10^{-2} and 21 atmospheres. Congruent melting was observed at T = 2575 ± 20°C and P = 5 ± 1 atmospheres. With lower nitrogen pressures, the melting point was related to the applied (or decomposition) pressure by the equation $\log P_{atmos}(N_2) = 18.5 - 5.1 \times 10^4/T$. The electrical resistivities of samples prepared from these melts were measured at temperatures between 150 and 900°K. The room temperature resistivity of congruently melted samples was 21 μΩ-cm, which may be compared with the value of 75 μΩ-cm for cerium metal at this temperature. These samples had a positive (metallic) temperature dependence of resistivity of 0.11 μΩ-cm/°C at room temperature and increased with temperature to a value of 0.22 μΩ-cm/°C at a temperature of 700°K. The noncongruently melted samples had a similar behavior, but with somewhat higher values of resistivity. The room temperature Seebeck coefficients for both types of samples were approximately +5 μV/°C, relative to platinum. (auth)

20891 PROSPECTS FOR HIGH-STRENGTH ZIRCONIUM ALLOYS. McDonald, N. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Aust. Inst. Metals; 16: No. 4, 179-94(Dec 1971).

The application of zirconium alloys that places a premium on strength is its use as pressure tubes in water-cooled nuclear reactors. For current operation near 300°C the economic incentive to reduce the wall thickness of tubes is large. It is concluded that improved understanding of the behavior of currently used Zircaloy-2 and zirconium-2.5% niobium alloys provides a better prospect for such a reduction than does development of a stronger alloy. Creep and creep rupture in the presence of a fast neutron flux is of most importance in this respect. A new, creep-resistant alloy is required for tubes to contain superheated steam at 450 to 500°C. The possible composition of such an alloy is restricted by the neutron capture cross-sections of alloying elements and by the nature of their contribution to hardening processes in zirconium. The useful alloying elements are restricted to aluminum, tin, niobium, molybdenum, oxygen and silicon. A brief summary is given of the information on these matters which has defined the alloy compositions being studied and their likely properties. (auth) (Australia)

20892 CONSTITUTION DIAGRAM OF THE SYSTEM LANTHANUM–GERMANIUM IN THE 50 TO 100 AT. PERCENT GERMANIUM RANGE. Eremenko, V. N.; Zyong Kuok Shi; Buyanov, Yu. I.; Batalin, V. G. (Inst. of Materials Science, Kiev. Kiev State Univ.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 8, 661-4(Aug 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 8, 82-6(Aug 1971).

Using the results of metallographic, differential thermal, dilatometric, and x-ray phase analyses, a constitution diagram of the system lanthanum–germanium was constructed covering the range of compositions from 50 to 100 at. % Ge. The existence was confirmed of the following germanide phases: LaGe with the FeB type structure and $LaGe_2$ with α-$GdSi_2$ and α-$ThSi_2$ type structures. It was demonstrated that the LaGe phase undergoes no polymorphic transformation. (auth)

20893 EFFECT OF ADDITIONAL ELEMENTS ON THE DUCTILE-BRITTLE TRANSITION TEMPERATURE OF FERRITIC STEELS OF THE Fe–Cr–Al AND Fe–Cr–Al–Si TYPE. Guiraldenq, Pierre (Compagnie des Ateliers et Forges de la Loire, Unieux, France); Coriou, Henri; Grall, Lucien. Compt. Rend., Ser. C; 273: No. 23, 1613-16(8 Dec 1971). (In French).

It is difficult to transform binary Al ferrites at high temperatures. Additional elements are proposed which improve the ductility without affecting the inoxidizability or the permeability to neutrons. The variations in the ductile-brittle transition temperature, Tc, for the ferrites Fe–Cr–Al and Fe–Cr–Al–Si in the hardened state were studied as a function of the composition of these alloys. The beneficial action of Cr on the ductility, the embrittling action of Si, and the different preparation methods are discussed. (France)

20894 METHOD OF COMPARING THE MECHANICAL PROPERTIES OF METALS TESTED AT DIFFERENT TEMPERATURES. Klyucharev, N. A. (Moscow Aviation Tech. Inst.). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 6, 922-4(Jun 1971).

Translated from Zavod. Lab.; 37: No. 6, 721-2(Jun 1971).

It is noted that in determining the mechanical properties of metals it is often necessary to compare the appropriate characteristics especially strength. This comparison may be made by determining the relations of the absolute test temperature (T_t) with the absolute melting temperature (T_m). It is shown that homologous temperatures may be used to indicate the relative nearness of the test or deformation temperatures to the absolute melting temperature and that homologous temperatures show the nearness of T_t to absolute zero. Diagrams of homologous temperatures and melting temperatures are used to illustrate the theories. (J.R.D.)

20895 ADSORPTION EFFECTS IN TUNGSTEN–OXYGEN–BROMINE REACTION. Zubler, E. G. (General Electric Co., Cleveland). J. Phys. Chem.; 76: No. 3, 320-2(3 Feb 1972).

In a microbalance-flow system, the reaction rate of W(s) at 700 to 900° in Ar, He, and N_2 with 10^{-3} to 10^{-2} torr oxygen and 0.01 to 3 torr bromine was linear with oxygen, but a complicated function of bromine and inert carrier gas. Except at the lowest bromine pressures, adsorbed bromine inhibited the reaction and the rate was higher in N_2 than Ar or He where the rate was the same. These observations are explained qualitatively by the two-layer adsorption model proposed by Schissel and Trulson for tungsten oxidation. (auth)

20896 EVALUATION OF SLIP PATTERNS OBSERVED IN ASSOCIATION WITH DEFORMATION TWINS IN Mo–35 AT. PERCENT Re ALLOY. Mahajan, S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., F (London); 2: No. 1, 19-23 (Jan 1972).

The crystallographic features of twins terminating inside the grains and of associated emissary slip were correlated using transmission electron microscopy. It was observed that when the slip patterns are simple, the Burgers vector of slip dislocations is always parallel to the direction of the twinning shear: this conclusion is consistent with the suggestions of Hull (1961, 1964) and Sleeswyk (1962). It is proposed that the emissary substructures evolve to relax the stresses at the tips of the twins which have stopped growing inside the crystal, and their evolution could be rationalized in terms of Hull's coalescence model. It is suggested that the coalescence reaction is more likely to occur than the dissociation reaction proposed by Sleeswyk, because the former is energetically less unfavorable. (auth)

20897 INCREASING THE PHYSICAL AND MECHANICAL PROPERTIES OF NIOBIUM AND ITS ALLOYS BY NITRIDING. Lakhtin, Yu. M.; Kogan, Ya. D.; Bobok, A. N. Vestn. Mashinostr.; No. 7, 65-7(1971). (In Russian).

Results are presented for studies of the influence of nitriding on increasing hardness and heat resistance of the alloy Nb–1% Zr. Nitriding is an effective method of surface alloying of niobium and its alloys and creates a heterophase structure, consisting of a high-strength nitride layer and a low-nitrogen solid solution including nitrides. Nitriding causes an increase in the hardness of niobium which is determined by the nitriding temperature, reaching its maximum value in the center of the specimen at 1500°C, on the surface at 1300°C. Nitriding suppresses recrystallization processes in the surface layers of products. The maximum increase in heat resistance is achieved by nitriding at 1200°C for 1 h. (JPRS)

20898 ANHARMONIC PROPERTIES OF THE HEXAGONAL METALS, MAGNESIUM, ZINC, AND BERYLLIUM. II. THERMAL EXPANSION. Srinivasan, R.; Rao, R. Ramji (Indian Inst.

of Tech., Madras). J. Phys. Chem. Solids; 33: No. 2, 491-9(Feb 1972).

The generalized Gruneisen parameters $\gamma'' = -\partial \log \omega/\partial\epsilon''$ and $\gamma' = -\partial \log \omega/\partial\epsilon'$ were calculated for various normal mode frequencies in magnesium, zinc, and beryllium using the model previously outlined (J. Phys. Chem. Solids; 32: 1769(1971)). The temperature dependence of the effective Gruneisen functions $\bar{\gamma}_{||}(T)$ and $\bar{\gamma}_{\perp}(T)$ were calculated. In magnesium the theoretical curve of $\bar{\gamma}_{\perp}(T)$ was in good agreement with experiment but the theoretical curve for $\bar{\gamma}_{||}(T)$ was about 10% higher than the experimental values over the entire temperature range. In zinc the $\bar{\gamma}_{||}(T)$ vs T curve exhibited a steep maximum at low temperatures. While the shapes of the theoretically calculated lattice Gruneisen functions $\bar{\gamma}_{||}(T)$ and $\bar{\gamma}_{\perp}(T)$ curves were similar to the experimentally observed variation of the total Gruneisen functions, the theoretical values were much higher than the experimental values. The reason for the discrepancy is the extreme sensitivity of the GPs of the low frequency modes corresponding to wave vectors lying on the vertical edge of the Brillouin zone. Perhaps a direct measurement of the pressure dependence of these frequencies in zinc by inelastic scattering of neutrons will provide more reliable values for the anharmonic parameters. The low temperature limit of $\bar{\gamma}_{||}(T)$ which depends on the TOE constants of the material did not agree with the value obtained by Barron and Munn (Phil. Mag.; 15: 85(1967)) in their analysis of the thermal expansion data. Possibly their choice of the electronic Gruneisen parameters is not correct. In beryllium there was no reliable experimental data to make a comparison with the calculated temperature dependence of the lattice Gruneisen functions. The variation of the generalized GPs of the elastic modes with the direction of propagation was illustrated by polar diagrams in the three metals. (auth)

20899 METALLOGRAPHIC STUDY OF MICROIRREGULARITIES OF CERTAIN NIOBIUM-BASED ALLOYS. Ozerova, E. I.; Mel'nikova, L. V. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 28-34(1971). (In Russian).

Nb alloys showed a tendency toward formation of low-angle polygonization boundaries in the cast, deformed, and annealed states. (JPRS)

20900 SEGREGATION OF A FCC PHASE IN THE QUATERNARY SYSTEM MOLYBDENUM–ZIRCONIUM–CHROMIUM–CARBON. Despotovic, Z.; Duzevic, D. Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 10, 834-44(Oct 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 10, 88-100(Oct 1971).

As-cast specimens from the 50-at. % C section of the quaternary system Mo–Zr–Cr–C were studied to establish the existence of a wide fcc-phase field exhibiting marked dendritic segregation. The field is bounded by the 0 and ~25 at. % Cr tie lines. A chromium addition substantially intensifies the segregation, resulting in division of diffraction lines, and appreciably increases the microhardness of the dendrite axes. The resultant microhardness attains a value of almost 5000 kg/mm^2. Annealing for 100 h at 1350°C is insufficient to achieve a state of phase equilibrium. The segregation persists. Polymorphic-peritectic decomposition takes place in the interaxial zones of the segregated fcc phase. During melting, specimens were found to exhibit a steady loss of chromium (5 to 10 at. %), but the proportions of the remaining components were substantially unchanged. Annealing for 100 h at 1350°C also has virtually no effect on the chemical composition of these alloys. (auth)

20901 EFFECT OF THE LEACHING TEMPERATURE ON THE STRUCTURE OF SKELETAL NICKEL CATALYSTS CONTAINING Mo, Fe, Cr, AND W. Nalibaev, T. N.; Talipov, G. Sh.; Fasman, A. B. Kinet. Katal.; 12: No. 4, 1080-3(Jul-Aug 1971). (In Russian).

The phase composition of ternary alloys represented by Ni_{50-x}–50% Al–M_x, where M is Mo, Fe, Cr, or W was followed by x ray diffraction patterns before and after a leaching period with NaOH solutions. The temperature of the leaching process was controlled at 100, 150, 165, 200 and 240°C, and the time varied between 1.5 and 2.0 h. The structure of the skeletal catalysts which resulted from the leaching process was dependent upon the leaching temperature. (K.S.W.)

20902 STRUCTURE AND MECHANICAL PROPERTIES OF ALLOYS OF NIOBIUM WITH CARBON AS FUNCTIONS OF HEAT TREATMENT. Tikhonova, G. S.; Mel'nikova, L. V.; Zheleznyak, O. N.; Konovalov, S. V. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 50-6(1971). (In Russian).

The alloy 5VMTs with 0.05% C was found to be heterogeneous in its structure. The mechanical properties of the sheet material at high temperatures depended on the phase composition, resulting from the heat treatment mode. (JPRS)

20903 SOME COMMENTS ABOUT INTERFERENCE CONTRAST IN QUANTITATIVE AND COLOR MICROSCOPY. Mihajlovic, A. (Boris Kidric Inst. for Nuclear Science, Belgrade). Metallography; 5: No. 1, 1-11(Feb 1972).

Results of an improved interference contrast method in study of solid state phase transformations and segregation of alloying elements are presented. By proper adjustment of monochromatic light (mercury lamp), green filter, "Nomarsky"-attachment, polarizer and analyzer, the sharp contours of martensitic α'-plates were obtained in the heavily oxidized U-0.45 wt % Mo alloy specimens. The sharp contours of plates were used in determining the growth rate, by measuring their change in width, in length and in surface area. The same combination, without a filter, produces the coloring effect on the specimens, without special chemical treatment. The Cu–Be, Cu–Zr, and Cu–Be–Ni alloys after electrolytic polishing and C–Si pyrolytic deposits were examined. It appears that the nonuniform amount of the alloying elements in the different zones of the specimens results in different absorption at light spectra. This coloring effect indicates the segregation of the alloying elements. (auth)

20904 TEM OBSERVATIONS OF GRAIN BOUNDARIES IN THE CAST NICKEL-BASE SUPERALLOY IN 100. Phillips, Victor A. (General Electric Research and Development Center, Schenectady, N. Y.). Metallography; 5: No. 1, 69-89(Feb 1972).

Alloy IN 100 solution-treated for 48 hours at 2225°F developed ordered $\gamma'(Ni_3Al)$ films at grain boundaries on aging for 500 hours at 1800°F. The films were observed to be divided into two by a high-angle grain boundary. They contained $M_{23}C_6$ particles (a_0 10.714 ± 0.001 Å) which were epitaxially related to the γ' film, with identical orientation, had approximately three times the parameter, and had dislocation-type interfaces. The observations were consistent with γ' film formation by reaction of γ and primary MC. The ordered γ' film was identically oriented with the adjoining (disordered) γ matrix and showed a dislocation-type interface. Preferential thinning was observed at γ–γ' interfaces and at grain boundaries. The γ' intragranular particles were identically oriented with the γ' film and were inferred to have the same parameter. The extracted residue showed MC or M (C, N) type carbides of a_0 4.31 ± 0.01 Å in addition to $M_{23}C_6$. The evidence suggests that the particles were (Ti, Mo) C, and $Cr_{23}C_6$ or $Cr_{21}Mo_2C_6$, respectively. The $M_{23}C_6$ particles apparently contained antiphase boundaries and, when extracted, showed a complex fine structure in the electron diffraction spots. There was evidence of agglomeration of groups of $M_{23}C_6$ particles inside γ' films. (auth)

20905 DIFFUSION OF CARBON, NITROGEN, AND OXYGEN IN VANADIUM BETWEEN 60 AND 1825°C. Schmidt, F. A.; Warner, J. C. (Ames Lab., Iowa). J. Less-Common Metals; 26: No. 2, 325-6(Feb 1972).

Previously measured diffusion coefficients of C, N, and O in V were combined to obtain rather precise estimates of the activation energy and pre-exponential factors over a large range of temperature. The data indicate that log D is a linear function of 1/T over the extended range from near room temperature to 1825°C for all three solutes. However, the validity of the combined results over the large temperature range hinges on the assumption that ΔH is constant throughout. A test was made for linearity in the combined plots for C, N, and O with no indication of curvature being observed. (P.C.H.)

20906 OBSERVATIONS ON SOLID SOLUBILITIES IN THE TRANSITION ELEMENTS OF GROUPS IV TO VII. Raynor, G. V. (Univ. of Birmingham, Eng.). J. Less-Common Metals; 26: No. 2, 303-12(Feb 1972).

Available data are graphically presented and briefly discussed for the solid solubilities of the elements of Groups IIIA to VIIA, and of Groups VIII and IB of the Periodic Table in the body-centered cubic transition metals of Groups IVA to VIIA. There is a general tendency for the solid solubility in a solvent metal for which the component of bonding due to d electrons is strong to decrease rapidly and systematically as the d-component of bonding in the solute element decreases. This supports the suggestion that extensive solid solution formation in the transition elements depends intimately on the degree to which the bonding characteristics of the solvent metal can be reproduced in the solid solution. The data presented also suggest that the theoretical treatment of the cohesion of the noble metals, and those immediately following them in their respective series, may be inappropriate for the transition metals without due allowance for the directional properties resulting from the variable participation of d electrons in the bonding processes. (auth)

20907 ELECTROTRANSPORT OF CARBON IN NIOBIUM AND TANTALUM. Schmidt, F. A.; Carlson, O. N. (Ames Lab., Iowa). J. Less-Common Metals; 26: No. 2, 247-53(Feb 1972).

The electrotransport velocity of carbon in niobium and tantalum was measured at temperatures above 1900°C using ^{14}C as a tracer. In both metals carbon was found to migrate in the opposite direction to the electron flow. The diffusion coefficients and effective charge were also calculated for this solute at the same temperatures. A least-squares treatment was made of the combined diffusion data of this study and that obtained at lower temperatures by others. Values of D_0 and ΔH in the equation $D = D_0 \exp(-\Delta H/RT)$, were determined for the extended temperature range and are as follows: Nb at 130 to 2340°C, $D_0 = 0.0100$ cm²/sec and $\Delta H = 33.92$ kcal/mole and Ta at 190 to 2680°C, $D_0 = 0.0067$ cm²/sec and $\Delta H = 38.60$ kcal/mole. (auth)

20908 FIELD-ION MICROSCOPY STUDY OF CHEMICALLY VAPOUR DEPOSITED MOLYBDENUM AND TUNGSTEN THIN FILMS. Boyes, E. D. (General Electric Co. Ltd., Wembley, Eng.). J. Less-Common Metals; 26: No. 2, 207-21(Feb 1972).

Films of molybdenum and tungsten 0 to 500 Å thick have been chemically vapor deposited onto field-ion emitter substrates by the thermal decomposition of the appropriate hexacarbonyl. Epitaxial molybdenum films on tungsten substrates could be progressively field evaporated to reveal the interface. Molybdenum film structure and purity were found to be dependent on deposition temperature, previous substrate thermal rearrangement, and vacuum conditions. Tungsten films on field evaporated molybdenum substrates were of high purity, epitaxial, and comparatively insensitive to deposition conditions while those on platinum were non-epitaxial but with a pronounced ⟨211⟩ texture. (auth)

20909 PROCHNOST' TVERDYKH SPLAVOV. Izdanie Vtoroe, Pererabotannoe i Dopolnennoe. (Strength of Hard Alloys. Second Edition, Revised and Enlarged). Kreimer, G. S. Moscow; Izdatel'stvo Metallurgiya (1971). 248p.

The hard tungsten carbide–cobalt alloys discussed in this monograph are essentially of four types: WC–Co, WC–TiC–Co, WC–Ta–Co, and WC–TiC–TaC–Co. Experimental data on their respective strengths at various temperatures are reviewed in terms of the basic structure of the alloys. Deformation by bending, compression, and the pertinent mechanisms associated with such deformation, durability, Poisson coefficients, thermal stability, moduli of elasticity, impact viscosity, bending strengths, and thermal microstresses are discussed. (250 references) (K.S.W.)

20910 SYSTEM SILVER–GADOLINIUM. Kiessler, Gonde; Gebhardt, Erich; Steeb, Siegfried (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 26: No. 2, 293-8(Feb 1972). (In German).

The constitution of the silver–gadolinium system has been investigated by thermal analysis, microscopical examination, and x-ray diffraction. Three intermetallic compounds, Ag_3Gd, Ag_2Gd, and AgGd, were found to exist. The compounds Ag_3Gd and AgGd have congruently melting maxima at 975 and 1100°C, respectively, and the compound Ag_2Gd is formed peritectically from Ag_3Gd and the melt. Ag_3Gd is hcp of the Ag_3Pu-type, Ag_2Gd tetragonal of the $MoSi_2$-type, and AgGd bcc of the CsCl-type. The complete system is divided into three partial systems. On the Ag-rich and the Gd-rich sides are the primitive eutectic partial systems with eutectic points at 11 and 77.5 at.% Gd and eutectic temperatures at 780 and 790°C. In the partial system Ag_3Gd–AgGd between there is a peritectic and also an eutectic reaction at 830 and 825°C, and at concentrations of 35 and 37 at.% Gd, respectively. The solid solubility of Gd in Ag is less than 2 at.%. In constitution the Ag–Gd system was very similar to the previously published systems Ag–Y[1], Ag–Sm[1], Ag–Ho[2], and Ag–Er[3]. (auth)

20911 THEORY OF THE SURFACE BOND IN ADSORPTION. Grimley, T. B. (Univ. of Liverpool). Ber. Bunsenges. Phys. Chem.; 75: No. 10, 1003-8(Oct 1971).

The isosteric heat of adsorption can be measured using a field electron microscope by determining the degree of surface coverage from work function measurements. This method has been improved by making use of a Faraday cage for the measurement of the electron current from a crystal face, by a better control of gas purity, and by a more accurate measurement of temperature and pressure. In this way, the heat of adsorption of hydrogen on tungsten (100), (111), (013), (114), (122), and (123) faces could be measured more precisely as a function of the degree of coverage. If the surface coverage is low only small differences exist between the heats of adsorption of the various faces ($35 < q < 39$ kcal/mol for $\theta < 0.1$). In case of high coverage ($0.1 < \theta < 1$) a considerable face dependence shows up which can be interpreted in terms of the structure of the various crystal faces. (auth)

20912 LATTICE STRAIN AND SOME PROPERTIES OF β-QUENCHED ZIRCONIUM–CHROMIUM ALLOYS. Rumball, W. M. (Chalk River Nuclear Labs., Ont.). J. Less-Common Metals; 26: No. 2, 321-4(Feb 1972).

X-ray line broadening measurements were made on water-quenched Zr alloys containing up to 1.46 wt.% Cr. The results showed that the mean lattice strain (ϵ) of the 1050 ppM O alloys increased linearly, crystallite size decreased, and hardness increased with increased Cr concentration. Thus, Cr strains the Zr lattice, as does O in the absence of Cr, but in the presence of Cr, O reduces lattice strain, which suggests a strong Cr/O interaction. Previous studies that showed that hardness could be related to the lattice strain and crystallite size and that crystallite size made the biggest contribution to hardness were substantiated. (P.C.H.)

20913 THERMODYNAMIC PROPERTIES OF URANIUM–ALUMINUM ALLOYS. Lebedev, V. A.; Sal'nikov, V. I.; Nichkov, I. F.; Raspopin, S. P. At. Energ. (USSR); 32: No. 2, 115-18(Feb 1972). (In Russian).

The thermodynamic properties of liquid solutions of uranium in aluminum and compounds UAl_4, UAl_3, and UAl_2 were measured by the emf method. The formation of such solutions is accompanied by the evolution of large quantities of heat. The activity of U in solutions obeys Henry's law, while the activity of Al obeys Raul's law. The temperature dependence of the activity coefficient of U in solutions (relative to $^{\gamma}U$) is given by: $\log {}^{\gamma}U = 3.672 - (7266/T) \pm 0.051$. The temperature dependence of the solubility of U in Al is given by: $\log {}^{x}U = -0.406 - (1172/T) \pm 0.080$ (730 to 870°C); $\log {}^{x}U = -0.230 - (1808/T) \pm 0.080$ (640 to 730°C). The partial free energy of α-uranium in UAl_4, UAl_3, and UAl_2 is given by the equations: $\Delta G\ UAl_4 = -29.70 + 4.3 \cdot 10^{-3} T \pm 0.10$ kcal/g·atom; $\Delta G\ UAl_3 = -29.3 + 4.1 \cdot 10^{-3} T \pm 0.10$ kcal/g·atom; $\Delta G\ UAl_2 = -12.10 - 1.8 \cdot 10^{-3} T \pm 0.44$ kcal/g·atom. (auth)

20914 DECOMPOSITION OF Th_3N_4 AND Th_2N_2O. Kusakabe, Takao; Imoto, Shosuke (Osaka Univ.). J. Jap. Inst. Metals; 35: No. 12, 1115-20(Dec 1971). (In Japanese).

Th_3N_4 and Th_2N_2O were thermally decomposed in the temperature range of 1200 to 1350°C in vacuum. In both cases, the lattice parameter of ThN produced by the decomposition showed 5.156 ~ 5.161 Å in good agreement with those previously reported, when the decomposition was nearly completed. But, when the product contained a large amount of the undecomposed Th_3N_4 or Th_2N_2O phase, a value as high as 5.180 Å was observed. The equilibrium nitrogen pressures for the reactions $Th_3N_4 \rightleftharpoons ThN$ and $Th_2N_2O \rightleftharpoons ThN + ThO_2$ were determined by heating the specimen in a disk form on a W strip heater up to 1985°C under the predetermined N_2 pressures and by measuring the decomposition temperature from the change of the specific emissivity at the point. The results are $\log P_{N_2}$ (atm) $= 6.209 - 1.399 \times 10^4/T$ for $Th_3N_4 \rightleftharpoons ThN$, and $\log P_{N_2}$ (atm) $= 13.544 - 3.095 \times 10^4/T$ for $Th_2N_2O \rightleftharpoons ThN + ThO_2$, which give the enthalpy and the entropy of formation of ThN and Th_2N_2O at 298°K as follows: $\Delta H_{298°K}$ (ThN) $= -186.2$ kcal/mole N_2, $\Delta S_{298°K}$ (ThN) $= -50.2$ eu/mole N_2, $\Delta H_{298°K}$ (Th_2N_2O) $= -321.7$ kcal/mole N_2, and $\Delta S_{298°K}$ (Th_2N_2O) $= -76.2$ eu/mole N_2. (auth)

20915 ANOMALIES IN THE ENTHALPY OF MIXING IN ALPHA-PHASE INDIUM–TIN DUE TO BRILLOUIN ZONE EFFECTS. Luova, Pertti; Korvenkangas, Unto; Pakkanen, Lauri (Univ. of Turku, Finland). J. Less-Common Metals; 26: No. 2, 299-302(Feb 1972).

Enthalpies of crystallization have been measured for indium–tin alloys containing 7 to 9 at.% tin using differential thermal analysis (DTA). From the values obtained the enthalpies of mixing, ΔH_m, in the solid state were calculated. In the ΔH_m vs composition curve there was a change in slope at 7.80 at.% tin, a maximum at 8.10 %, and a sharp minimum at 8.31%. This behavior is qualitatively explained by varying electronic and lattice energies in connection with Fermi surface—Brillouin zone interaction. New pieces of Fermi surface in the third zone were assumed to appear at 8.10 at.% tin. The height of the dip was about 1.2 MeV/atom. (auth)

20916 CRYSTAL STRUCTURES OF SOME Ln_3Rh, Ln_7Rh_3, AND $LnRh_3$ PHASES. Raman, A. (Louisiana State Univ., Baton Rouge). J. Less-Common Metals; 26: No. 2, 199-206 (Feb 1972).

The Fe_3C-type structure occurs in the phases Nd_3Rh, Gd_3Rh, Y_3Rh, and Er_3Rh. The atomic positional parameters in the Pnma space group are given. Phases with the Ln_7Rh_3 stoichiometry in

the Gd–Rh, Y–Rh, and Er–Rh systems possess the Th_7Fe_3-type structure. The same structure occurs in the alloys of the light rare earths, La, Ce, and Nd at the Ln_3Rh stoichiometry. Unlike $LaRh_3$ and $NdRh_3$, $CeRh_3$ crystallizes in the Cu_3Au-type structure. It is shown that electronic factors rather than the size factor play prominent roles in stabilizing these structures in the rare earth alloys. (auth)

20917 DATA SHEET FOR TITANIUM AND TITANIUM ALLOYS. 3. Ti–8Al–1Mo–1V ALLOY. Nakano, O. (National Research Inst. for Metals, Tokyo). Chitaniumu Jirukonium; 19: No. 7, 14-21(Jul 1971). (In Japanese).

Characteristics of Ti–8Al–1Mo–1V alloy are summarized with reference to data on the Ti–8Al–1Mo–1V alloy which have been reported by others. First, in connection with mechanical properties of the Ti–8Al–1Mo–1V alloy, notch effects at room temperature in changing annealing conditions are given and the effects of several factors that influence notch effect at high temperature are discussed. Moreover, properties of compression, impact, torsion and shearing, rupture toughness, creep and creep fracture, fatigue, and elasticity of the Ti–8Al–1Mo–1V alloy are given. Second, in connection with manufacture of the Ti–8Al–1Mo–1V alloy, forming, machining, and welding are discussed in reference to those of Ti–6Al–4V alloy. Finally, with regard to physical properties of the Ti–8Al–1Mo–1V alloy, thermal properties, such as melting point, phase transformation, thermal conductivity, thermal expansion, density, and electrical resistance are given. With regard to chemical properties of the Ti–8Al–1Mo–1V alloy, corrosion resistance, salt corrosion, and retarded fracture are discussed. (Japan)

20918 INCREASING THE RESISTANCE OF BERYLLIUM TO MICROPLASTIC DEFORMATION BY THERMOCYCLIC TREATMENT. Khenkin, M. L.; Lokshin, I. Kh.; Levina, N. K.; Akopov, I. A. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 7-8, 583-5(Jul-Aug 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 7, 50-2(Jul 1971).

Studies were made on the effects of thermocyclic stabilizing treatment (TST) on the relaxation resistance and reduction of microstresses in Be. The results showed that after TST with thermocycling from −50 to 100°C the relaxation resistance more than doubled in tests at constant temperature. The effectiveness of TST increased if the upper temperature of the cycle did not exceed 400°C. With further increase in the upper temperature, the effectiveness of TST decreased and at 600°C was equal to zero. With the lower temperature of the cycle at −50°C, the strengthening coefficient was about 15% below that with the lower temperature at −196°C. Thus, the effectiveness of TST increased with the range between the upper and lower temperatures of the cycle when the upper temperature of the cycle did not exceed 400°C. Along with the higher relaxation resistance, TST also reduced the macrostresses. It was concluded that the increase in the resistance of Be to microplastic deformation under prolonged stress is due to the accelerated relaxation of microstresses in overstressed microvolumes and stabilization of the fine structure in these volumes during thermocycling. (P.C.H.)

20919 COMPOSITE MATERIALS OF NICHROME WITH MOLYBDENUM AND WITH TUNGSTEN. Banas, F. P.; Natapov, B. S.; Efimenko, L. N.; Gaiduk, V. V.; Aleksandrov, B. V. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 7-8, 626-30(Jul-Aug 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 8, 6-11(Aug 1971).

Composite materials, manufactured by hot pressing in a vacuum chamber with the ends of the pack open, were examined. The results showed that hot isothermal pressing of nickel–chromium composites reinforced with refractory filaments makes it possible to regulate the parameters of the process and ensures obtaining a dense material with a given distribution of filament and high volume percentage of the filament. In combination with subsequent rolling, this method makes it possible to manufacture dense materials strengthened with grids. A white nonetching zone is formed at the filament–matrix interface, which is evidently a solid solution of chromium with WNi_4 and $MoNi_n$, the hardness of which is substantially higher than that of the filament or matrix. The distribution of tungsten, molybdenum, nickel, and chromium in the transition zone indicates that the overall depth of interdiffusion matches the width of the white nonetching zone. The rate of interdiffusion between filament and matrix at 1100°C is stabilized in 250 h for a tungsten filament and in 500 h for a molybdenum filament. The width of the transition zone in the nickel–chromium materials with molybdenum filament is about 10 times larger than with tungsten filament. The solution of tungsten filament in the nickel–chromium matrix containing tungsten is substantially lower than in the matrix without tungsten. The solution of molybdenum filaments is almost the same in both matrices. From the relationships established for interdiffusion between the matrix of nickel–chromium materials and filaments of tungsten and molybdenum it is possible to select the diameter of the filament and thickness of the protective layer of the matrix in relation to the desired operating temperature and operating life. (auth)

20920 TUNGSTEN FILAMENT AS REINFORCEMENT FOR HEAT RESISTANT COMPOSITE MATERIALS. Fonshtein, N. M.; Kotov, V. F.; Tikhomirova, G. N.; Shvarts, V. I. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 7-8, 631-4(Jul-Aug 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 8, 11-14(Aug 1971).

The mechanical properties and microstructure of W filaments were investigated as reinforcement for heat-resistant composite materials. Wire samples 25 to 500 μ in diameter of "nonsagging" VA tungsten with a small amount of compound $Al_2O_3 + SiO_2 + KCl$ to ensure retention of the deformation texture (and the corresponding high original strength) up to 1400 to 1600°C were studied. Optimal conditions for preparing the filament were also considered. The results showed that the grain growth of W due to the influence of Ni may result from a lower activation energy of self-diffusion of W as a consequence of alloying with Ni, and the substantial reduction of the melting point (and recrystallization temperature) with increasing concentrations of Ni in the alloy with W. The results of microhardness measurements on samples annealed in contact with Ni indicated that alloying of W with Mo or Re lowered its sensitivity to the harmful influence of Ni. To ensure high long-term heat resistance of composite materials based on Nichrome reinforced with W, it is proposed that alloying of the reinforcing material be used along with special coatings to protect the reinforcement from the influence of the matrix and changes in the composition of the matrix. (P.C.H.)

20921 HEAT RESISTANT COMPOSITE MATERIALS: NICHROME–TUNGSTEN FILAMENT. Kotov, V. F.; Fonshtein, N. M.; Shvarts, V. I. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 7-8, 640-2(Jul-Aug 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 8, 20-2(Aug 1971).

Composite materials based on Nichrome reinforced with W filaments were investigated. To ensure minimal contact of W filaments with liquid Nichrome, the composite material was obtained by vacuum coating of the filament with the liquid matrix metal. Filaments of VA tungsten and W alloys VAM-5 and VAR-5, containing 5% Mo and Re, respectively were used as reinforcement. The interaction of the matrix with the filament during heating was characterized by the diffusion of reinforcing material to the matrix and recrystallization of the reinforcing material. The intensive interaction of W alloy filaments with the Nichrome matrix made it necessary to protect the refractory filaments against solution. Softening of the filament in the composite material during prolonged exposure to high temperatures was determined by microhardness measurements. With increasing temperature and time the microhardness decreased monotonically. It was concluded that the W–Nichrome composite materials have large reserves of long-term strength. (P.C.H.)

20922 CAST COMPOSITE ALLOY FOR PERFORATOR PARTS. Sidorin, I. I.; Solov'eva, T. V.; Eskin, G. I.; Silaeva, V. I.; Slotin, V. I. (Moscow Higher Technical School). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 7-8, 643-6(Jul-Aug 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 8, 23-6(Aug 1971).

A cast Al alloy developed for cases and some parts of hollow-charge perforators is discussed. The best properties were obtained for a composite with silicon carbide, for which the formation energy was low, as for all covalent crystals. It was possible to increase the wetting and adhesion capacity by creating microdefects in the crystal lattice, which are the covalent bonds and intensified s–d electron transfer with the addition of active impurities. Tests of the mechanical properties of various composites showed that they depend on the nature of the component, the amount, and the dispersity of the hardening particles. The composition of the composite material met the technological and operational requirements for perforator materials. It was also found that the composite based on a cast aluminum alloy was quite soluble in alkali solutions at 100 to 150°C, which ensures removal of the explosive fragments from boreholes. The combination of high strength, thermal stability, and brittleness made it possible to recommend the new composite for casings of hollow-charge perforators, thus permitting a broader range of perforation operations and greater depth of boreholes. (auth)

20923 BULK AND BOUNDARY DIFFUSION OF CHROMIUM IN MOLYBDENUM. Mulyakaev, L. M.; Dubinin, G. N.; Shcherbedinskii, G. V. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 7-8, 665-8(Jul-Aug 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 8, 45-8(Aug 1971).

A method which makes it possible to take into account the structural factor in the kinetics of diffusion processes and to determine the coefficient of bulk diffusion and the parameter of boundary diffusion simultaneously was used to study diffusion of Cr in Mo. The results showed that the coefficient of bulk diffusion of Cr in a Mo single crystal matched the diffusion coefficient in polycrystalline Mo. The boundary diffusion parameter of Cr in PM molybdenum was two to five times that in fused Mo. Values for the activation energy (Q) and the preexponential factor (D_0) of the processes were calculated by the method of least squares. Substantial difference in the values of the activation energy of boundary diffusion of Cr in PM and fused Mo (40.9 and 74.2 kcal/g-atom, respectively) confirmed the difference in the nature of the boundaries in polycrystalline Mo. Equations are given for bulk diffusion in PM, fused, and single crystal Mo and also for boundary diffusion in PM molybdenum. (P.C.H.)

20924 HEAT RESISTANT ALLOY EP677: SUBSTITUTE FOR ALLOY KhN67VMTYu. Zimina, L. N. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 7-8, 704-6(Jul-Aug 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 8, 75-6(Aug 1971).

The alloy EP677 with the composition ≤0.08% C, ≤0.4% Si, ≤0.5% Mn, ≤0.015% P, ≤0.01% S, 17 to 19% Cr, 4.6 to 5.6% Mo, 4.6 to 5.6% W, 7.5 to 10.5% Fe, 2.3 to 2.9% Ti, 1 to 1.5% Al, <0.005% B, and <0.01% Ce has been proposed as a substitute for the heat-resistant weldable alloy KhN67VMTYu. The addition of 10% Fe to alloy KhN67VMTYu substantially improved the mechanical properties at hot pressing temperatures. Alloy EP677 can be used for manufacturing thin-walled castings of complex shape. The casting characteristics of this alloy are similar to those of alloy KhN67VMTYu. Alloy EP677 also has good weldability in the cast and deformed conditions equal to that of the other alloy. Thus, alloy EP677 is not inferior to alloy KhN67VMTYu in its mechanical properties at operating temperatures, has better technological characteristics in hot pressing, and, since it is cheaper (not containing Ni), it is recommended as a replacement for alloy KhN67VMTYu in manufacturing serially produced and experimental parts intended for operation at temperatures from −253 to 850°C. (P.C.H.)

20925 EXPERIMENTAL AND THERMODYNAMIC INVESTIGATIONS OF THE REACTION OF TUNGSTEN WIRE WITH H_2O AT TEMPERATURES BETWEEN 1500 AND 2800°K. Almer, F. H. R.; Wiedijk, P. (Philips-Gloeilampenfabrieken Centraal Lab., Eindhoven, Netherlands). Z. Anorg. Allg. Chem.; 385: No. 3, 312-20(Nov 1971). (In German).

The reaction between tungsten and water vapor was studied in an incandescent lamp with a filament temperature between 1500 and 2800°K and the filament being placed in a carrier gas system. The change in the lamp current at constant dc voltage supply was used as an indicator of the reactive system. The experimental results supported a thermodynamic model in which the molecules O_1, O_2, H_2O, OH, H_1, H_2, W, WO, WO_2, WO_3, W_2O_6, W_3O_9, W_4O_{12} and $WO_2(OH)_2$, in the vapor form, took part in the reaction. (auth)

20926 SOME PROPERTIES OF BINARY VANADIUM ALLOYS. Marchukova, L. V.; Matveeva, N. M.; Kornilov, I. I. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 7-8, 594-5(Jul-Aug 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 7, 62-3(Jul 1971).

Studies were made on the structure and properties (hardness, density, and electric conductivity) of V alloys with Ti, Cr, Sn, and Al. The results showed that increasing the concentration of the alloying element in the binary alloys at concentrations of 0 to 25 wt % led to an increase in hardness and electric resistivity, particularly for alloys with tin and aluminum. The strength will be highest for alloys of vanadium with tin. (P.C.H.)

20927 STUDY OF DISTRIBUTION OF TANTALUM IN THE STRUCTURE OF YTTRIUM BY CONTACT MICROROENTGENOGRAPHY. Voskresenskaya, L. A.; Petukhova, A. S.; Pikunov, M. V. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 32: 34-7(1971). (In Russian).

The distribution of Ta in Y produced by various methods was studied. The method of contact microroentgenography was found to be the only possible method for this purpose. It was established that Y is contaminated to a significant extent with tantalum. The nature of the distribution of Ta in Y and the influence of Cu and Fe impurities on this distribution were determined. (JPRS)

20928 KINETICS OF THE CARBURIZATION OF NIOBIUM IN ACETYLENE OR METHANE ATMOSPHERES. II. CARBURIZATION IN METHANE. Hoerz, Gerhard; Lindenmaier, Klaus (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 63: No. 2, 103-6(Feb 1972). (In German).

The kinetics of the carburization of niobium in flowing methane has been investigated at temperatures between 1600 and 2150°C and at methane pressures between 2×10^{-3} and 1×10^{-1} torr. The reaction rate of the absorption of carbon in niobium has been followed by measuring the electrical resistivity continuously at the carburization temperature. The carbon absorption by thin niobium specimens in a methane atmosphere can be described by the relation $a_C = 57 \times p_{CH_4} \times t \times \exp(-7.35 \times 10^3/T)$ with a_C in $\mu g/cm^2$, p_{CH_4} in torr, t in sec and T in °K. This relation was valid for the carburization in pure methane as well as for the carburization in methane–hydrogen mixtures at hydrogen partial pressures up to 10^{-1} torr. The reaction coefficient r increased from 1.1×10^{-4} at 1600°C to 2.9×10^{-4} at 2200°C. The rate of carbon absorption by thin niobium specimens in a methane atmosphere was determined by the decomposition of methane molecules at the hot specimen surface (separation of the first hydrogen atom from the methane molecule). (auth)

20929 KINETICS OF THE CARBURIZATION OF NIOBIUM IN ACETYLENE OR METHANE ATMOSPHERES. I. EXPERIMENTAL PROCEDURE: CARBURIZATION IN ACETYLENE. Hoerz, Gerhard; Lindenmaier, Klaus (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 63: No. 2, 99-102(Feb 1972). (In German).

The kinetics of the carburization of niobium in flowing acetylene have been investigated at temperatures between 1500 and 2150°C and at acetylene pressures between 2×10^{-6} and 3×10^{-5} torr. The reaction rate of the absorption of carbon in niobium could be followed by measuring the electrical resistivity of the specimens continuously at the carburization temperature. The specific electrical resistivity of niobium in the temperature range of 1500 to 2150°C was increased by 3.5 $\mu\Omega \cdot$cm after 1 at. % carbon was dissolved. The carbon absorption by thin niobium specimens in an acetylene atmosphere can be described by the relation $a_C = 1.4 \times 10^4 \times p_{C_2H_2} \times t$ with a_C in $\mu g/cm^2$, $p_{C_2H_2}$ in torr and t in sec. The reaction coefficient r had a high value of 0.86, which was independent of the temperature. From this result it can be concluded that the rate of carbon absorption is determined by the transport of the cold acetylene gas to the specimen surface. The kinetics of the reaction of niobium with acetylene were not influenced by the presence of hydrogen gas of partial pressures up to 10^{-1} torr. (auth)

20930 OBSERVATION OF SEGREGATION IN Sn–Cd ALLOY MELTS USING NEUTRON RADIOGRAPHY. Reijonen, H. (State Inst. for Technical Research, Otaniemi, Finland); Forsten, J. J. Cryst. Growth; 12: No. 1, 61-2(Jan 1972).

Neutron radiography has been used to observe the segregation of cadmium in Sn–Cd alloys during melting. Liquid droplets with a lower melting point than the bulk material are formed during melting and, if these can fall to the mold bottom, Cd segregation is observed in the completely melted alloy. The observed phenomenon cannot be explained by ordinary gravity segregation. (auth)

20931 SENSITIVE TEMPERATURE MEASUREMENTS ON PURE METALS DURING FREEZING AND MELTING. McAllan, J. V. (CSIRO, Sydney). J. Cryst. Growth; 12: No. 1, 46-52(Jan 1972).

For standard reference temperature, samples of about 1 kg of pure metals are frozen and melted under carefully controlled conditions, temperatures being monitored by platinum resistance thermometry with a sensitivity of 0.1 m°C. Solid is nucleated on the crucible wall, and slow freezing segregates impurities to the central axis, where a thermometer indicates the temperatures which are stable to 0.1 m°C for 20 to 50% of the freezing time. Impurities segregate at different rates, and depress the freezing and melting temperatures by different amounts. During melting the heat flux inwards raises the outside temperature slightly above that of the center. The impure center melts first but the temperatures rises rapidly until the outside reaches its solidus value, and also melts. The thermometer measures only the temperature of the inside interface, which melts slowly, driven by the difference in melting temperatures between the two interfaces. The melting temperature depression is the sum of the separate impurity depressions, and the complex melting curve is characteristic of the

particular sample. Samples with impurities differing by 0.1 ppM can be distinguished with this technique, because impurities are concentrated by factors of up to 100 during freezing and the melting interface sweeps slowly through the impure zone. (auth)

Radiation Effects

Refer also to abstracts 20187, 20249, 22074, 22102, and 22365.

20932 (COO-1367-43) ELECTRON IRRADIATION STRENGTHENING OF MAGNESIUM AND ZINC SINGLE CRYSTALS AT 4.2°K. Mifune, T.; Urakami, A.; Sato, A.; Meshii, M. (Northwestern Univ., Evanston, Ill. Technological Inst.). [1970]. 20p. Dep. NTIS.

The effects of electron irradiation on the flow stress of magnesium and zinc single crystals oriented for basal slip were investigated. Tensile tests were performed before and after electron bombardment with 1 MeV energy at 4.2°K. An increase in the flow stress was observed after irradiation in the two hcp metals. The flow stress increase in both metals was found to be proportional to the square root of the electron dose. This irradiation strengthening effect in the hcp metals was similar to that found in previous studies on fcc metals, but it was opposite to the irradiation weakening effect found in pure iron. The present result adds support to the previous assertion that intrinsically hard crystals such as iron are softened by the presence of point defects that assist kink nucleation on screw dislocations, and that intrinsically soft crystals such as fcc and hcp (basal slip) crystals are hardened by the presence of point defects that hinder growth of kinks on dislocations. The magnitude of the irradiation strengthening effect in the two hcp metals was much smaller than that found in fcc metals. This is attributed to a large relaxation of radioinduced interstitials in hcp metals because of their crystallographic structure. The recovery of the electron irradiation hardening was also studied in the temperature range between 4.2 and 100°K. A large recovery step (~60% in Zn and ~40% in Mg) was found around 10°K in both metals. No appreciable recovery took place above 20°K. These observations of the recovery behavior of the hcp metals were quite different from that of the fcc metals studied previously. (auth)

20933 (NRL-7358) PROCEDURES FOR INTERPRETING THE STRUCTURAL IMPLICATIONS OF RADIATION-DAMAGE SURVEILLANCE RESULTS ON NUCLEAR PRESSURE VESSELS. Steele, L. E.; Serpan, C. Z. Jr. (Naval Research Lab., Washington, D. C.). 6 Oct 1971. 22p.

The structural implications of radiation effects to nuclear reactor pressure vessels are assessed primarily through surveillance programs in which the properties of the vessel are projected from an evaluation of small specimens of the vessel steel. In the USA, the current fracture-safe criterion requires that the vessel operating temperature, at certain stress levels, be at the fracture transition elastic (FTE) temperature, defined as NDT + 60°F, derived from surveillance measurements. Results of data reviews from five reactor surveillance programs indicate that this criterion is adequate for the vessels concerned. Complete assurance of fracture-safe operating conditions can be attained through a limit-analysis procedure that is used to integrate the effects of factors such as the radiation-induced shift in transition temperature, the initial shelf energy, the radiation-reduced ductile shelf energy, the effects of the fluence (and toughness) gradient through a thick vessel wall, and the effects of thickness-induced mechanical constraint. (auth)

20934 USE OF HVEM TO SIMULATE FAST-NEUTRON-INDUCED VOID GROWTH IN METALS. Norris, D. I. R. (Central Electricity Generating Board, Berkeley, Eng.). Jernkontorets Ann.; 155: No. 8, 525-6(1971). (CONF-710439-4).

From second international conference on high-voltage electron microscopy; Stockholm, Sweden (14 Apr 1971).

The void growth in fast reactor fuel cladding and structural materials due to fast neutron irradiation have been simulated by electron irradiation in the beam of a high voltage electron microscope (HVEM). Thin foils of nickel, where the ingredients for void nucleation have been provided beforehand by appropriate heavy ion bombardment, have been studied. The void concentration is found to decrease and the void size to increase with increasing irradiation temperature. The HVEM has been used to quantitatively determine the dose dependence of void swelling by taking micrographs of one area of a specimen at intervals during the irradiation with a constant electron flux. Voids are observed to grow at varying rates. They either shrink or coalesce with each other. At low doses, swelling is proportional to the square of the dose, while the dislocation structure is much influenced by the foil surfaces. At higher doses, a linear dependence takes over and voids absorb a constant fraction of all vacancies created. In this stage the swelling rate is in reasonable agreement with results for neutron-irradiated nickel. Dynamic effects in a thin foil electron microscope specimen are frequently not representative of bulk material behavior. Results show that void growth in an electron irradiated thin foil can simulate that in neutron-irradiated bulk material, dependent on the dislocation structure. (Sweden)

20935 GRAIN-BOUNDARY RELAXATION IN ALUMINUM ON NEUTRON IRRADIATION. Bose, S. K.; Mishra, R.; Bhattacharya, D. L. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 9: No. 9, 722-4(Sep 1971).

The effects of neutron irradiation on the internal friction versus temperature curves have been observed for specpure and commercially pure (2S) aluminum wire specimens, using the torsional pendulum method. At room temperature, the internal friction of the irradiated specimen was found to have values higher than those for the annealed ones. The grain boundary peak was found to be lowered by about 10% and shifted towards the lower temperature significantly. This effect can be best explained in terms of migration of interstitials in the dumb-bell configuration and trapping of dumb-bells by impurity atoms near the grain boundary. On annealing, these impurity atoms segregate near the grain boundary region and produce a depression of the peak. (auth)

20936 FUEL ROD IRRADIATION IN THE FR 2. Deckers, H.; Haefner, H.; Reiser, H. KFK Nachr.; 3: No. 2, 1-6(1971). (In German).

Irradiation tests on fuel rods have been conducted since 1965 in connection with a fast breeder program. A helium test loop used in the FR 2 is described, including an older short-irradiation device and a newer high pressure irradiation system. The latter operates at 75 to 150 atmospheres and 450 W/cm^2 maximum heat flux. A capsule test assembly is discussed which is capable of being handled like a fuel element at any position desired in the reactor lattice. Fuel elements in the form of oxides, nitrides, and carbides have been tested in over 200 positions in the FR 2 core in a wide range of temperatures and neutron fluxes. Creep and swelling are measured with special instrumentation. (K.S.W.)

20937 IRRADIATION ENHANCED PRECIPITATION IN STAINLESS STEEL. Fisher, S. B.; Williams, K. R. (Central Electricity Generating Board, Berkeley, Eng.). Phil. Mag.; 25: No. 2, 371-80(Feb 1972).

Experimental findings of an irradiation enhancement of precipitation in stainless steel under observation in the High Voltage Electron Microscope (HVEM) are presented. The results for the case of electron irradiation were compared with previous studies of precipitation under neutron irradiation in thermal and fast reactor conditions. Under low neutron fluxes precipitation was influenced by the production of vacancy clusters which act as nuclei. However, growth of these nuclei was limited unless the temperature was sufficiently high for thermal diffusion to be significant. Under fast reactor conditions the high neutron fluxes permitted growth to continue at irradiation temperatures ≥450°C, under the irradiation enhanced diffusion. The observations made in the HVEM showed that the production of vacancy clusters is not necessary for precipitation to occur under irradiation. Growth took place rapidly under the defect supersaturations provided by the electron beam. Extension of the theory of irradiation enhanced diffusion to the case of future fast reactor systems, where neutron fluxes were substantially higher than in the Dounreay Fast Reactor (DFR), indicated that in the former the cladding will be exposed to higher effective temperatures with regard to precipitation but for shorter periods. This may not necessarily be detrimental to the mechanical properties of the clad. (auth) (UK)

20938 FIELD ION MICROSCOPE EXAMINATION OF HEAVY ION RADIATION DAMAGE IN IRIDIUM. III. RESULTS. Hudson, J. A. (Atomic Energy Research Establishment, Harwell, Eng.); Ralph, B. Phil. Mag.; 25: No. 2, 265-80(Feb 1972).

Results of experiments in which iridium field ion specimens were bombarded with 20 to 100 keV heavy ions are presented. Specimens were bombarded in situ in the microscope at 78°K and room temperature to doses in the range 10^{11} to 10^{16} ions/cm^2. After room temperature irradiations field evaporation revealed radiation damage predominantly in the form of compact vacancy clusters and perfect dislocation loops. After irradiation at 78°K single vacancies, dispersed and compact clusters, and dislocation loops were observed. The size of the loops and compact clusters was independent of ion dose and independent of incident ion energy above 60 keV. Above this energy the mean cluster diameter was 25 Å while at lower ion energies many smaller vacancy aggregates were formed. The dispersed clusters contained about 100 vacancies in a concentration of 1 to 20%. Most of these clusters remained dispersed after annealing at room

temperature. Results of observing heavy ion damage iridium foils by transmission electron microscopy are briefly described together with preliminary annealing results. (auth)

20939 NEUTRON EMBRITTLEMENT OF STEELS AND ITS EFFECT ON VESSELS OF PRESSURIZED-WATER REACTORS. Bergemann, W. (VEB Kombinat Kraftwerksanlagenbau, Berlin. Vorbereitung Kernkraftwerke, Berlin). Kernenergie; 14: No. 10, 317-25(Oct 1971). (In German).

Neutron irradiation affects brittleness of the low-alloy vessel materials used in reactors. Test methods are available for this which can be used to indicate the effects of individual or combined factors on a special characteristic (e.g., notched-bar impact strength) and to incorporate such values into an operand to be used by the design engineer. The first group of test methods serves for covering relative values (e.g., for controlling the reactor vessel material with respect to neutron-induced embrittlement), the second group is used for dimensioning the structural units (e.g., fixation of a lower limiting temperature for certain operating regimes of the reactor). The tendency to brittle fracture may with high probability be suppressed by adequate measures. This review of literature is restricted to reproduction of aspects with respect to materials technology and does not include an interpretation of the phenomenon of brittle fracture from metallographic point of view. (auth)

Other Materials

Refer also to abstracts 20749 and 20824.

20940 (CONF-710938–, pp 33) GUARDED-LONGITUDINAL-HEAT-FLOW TECHNIQUE FOR MEASUREMENT OF THERMAL CONDUCTIVITY, ELECTRICAL RESISTIVITY, AND SEEBECK COEFFICIENT BETWEEN 300 AND 1000 K. Moore, J. P.; McElroy, D. L. (Oak Ridge National Lab., Tenn.). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20941 (CONF-710938–, pp 141-2) METHOD FOR THE SIMULTANEOUS DETERMINATION OF THE HIGH TEMPERATURE THERMAL CONDUCTIVITY AND THERMAL DIFFUSIVITY. Buzbee, B. L.; Dorr, F. W.; Wagner, P. (Los Alamos Scientific Lab., N. Mex.). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20942 (CONF-710938–, pp 170-1) THERMAL DIFFUSIVITY AND THERMAL CONDUCTIVITY OF PYROLYTIC GRAPHITE FROM 300 TO 2700°K. Null, M. R.; Lozier, W. W.; Moore, A. W. (Union Carbide Corp., Parma, Ohio. Carbon Products Div.). 1971.

From eleventh international conference on thermal conductivity; Albuquerque, N. Mex. (28 Sep 1971).

20943 (KURRI-TR-90) CHANGE OF SOME MECHANICAL PROPERTIES OF BORONATED GRAPHITE IRRADIATED IN A REACTOR. Kawata, Tomio; Murakami, Toru; Araki, Yasusuke; Kimura, Itsuro; Shibata, Toshikazu [Kyoto Univ. (Japan). Research Reactor Inst.]. [1971]. 12p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Changes of mechanical properties such as elastic constant, bending strength, and compressive strength of boronated and pure graphite after irradiation in KUR up to thermal neutron exposure of 8×10^{19} nvt were measured. Samples of boronated graphite were taken from blocks which contained about 3.6% boron in weight and were manufactured by an extrusion method with graphitization temperatures of 1400, 2000, and 2400°C. The results showed that the mechanical properties increased more rapidly by irradiation than those obtained by Davidson et al. Thereafter, some of the samples encased in instrumented capsules were irradiated at 350°C and showed less change in their mechanical properties than those irradiated at lower temperatures. From this fact, it is believed that the difference between the present results and those of Davidson et al. is caused by different irradiation temperatures. Comparison of irradiation behavior in boronated graphite with the results of pure graphite suggests that the effective damage on boronated graphite matrix induced by the $^{10}B(n,\alpha)$ reactions in B_4C dispersion is relatively small in spite of large energy release from these reactions. (auth)

20944 (RDT-M-3-20-T(1-72)) POLYETHYLENE INSTRUMENT TUBING. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 9p. RSO.

A standard prescribing requirements for polyethylene instrument tubing for nuclear and associated applications is presented. (J.R.D.)

20945 (TID–5578) FLAME SPRAY TECHNIQUE FOR GRAPHITE MOLDS. Stoddard, Stephen D. (Los Alamos Scientific Lab., N. Mex.). 9 Apr 1959. 4p. (CMB–6–2289). Dep. NTIS.

Declassified 19 Oct 1971.

To eliminate the need for prefiring high alumina composition, cold-sprayed mold coatings for plutonium casting, an investigation of flame-spraying techniques was undertaken. A Metco Type P Thermospray Gun with accompanying accessory equipment was used to apply two different alumina coatings to machined graphite molds. The coatings were evaluated and it appeared that the flame spray method is more economical and expeditious. (W.D.M.)

20946 (TID–5846) CORROSION OF GRAPHITE BY NITROGEN. Chapman, K. R. (Los Alamos Scientific Lab., N. Mex.). 1 May 1957. 3p. Dep. NTIS.

Declassified 20 Oct 1971.

Corrosion tests were made on uranium-loaded graphite tubes with nitrogen gas. From the gross results obtained, it is predicted that nitrogen gas can be used as a heat transfer medium in a graphite fuel element reactor operated at specified temperatures. (P.C.H.)

20947 (TID–15426) EFFECTS OF GAMMA-RAY IRRADIATION ON FIVE PLASTIC-BONDED HIGH EXPLOSIVE COMPOSITIONS. Mapes, James E.; Schwartz, Frank R.; Kaufman, J. V. Richard (Picatinny Arsenal, Dover, N. J.); Levy, Paul W. (Brookhaven National Lab., Upton, N. Y.). [1960]. 53p. Dep. NTIS.

Declassified 19 Oct 1971.

The physical changes in five plastic-bonded high explosive compositions induced by ^{60}Co gamma rays were studied for exposures up to 3.5×10^8 R at two rates, 4.5×10^4 and 2×10^5 R/hr. Some samples were given a single continuous exposure while others were exposed in successive increments to the same total dose and measured after each exposure. Diameter, length, and weight were measured, and volume and density were calculated. Detonation velocity and plate acceleration capability were tested on samples which have been continuously exposed. The explosives studies were 9404 HMX/Nc, HMX/Exon, HMX/Ps, ERS9 HMX/Nc, and DATB/Exon. (T.F.D.)

20948 INVESTIGATION OF RADIATION-INDUCED ELECTRIC CONDUCTIVITY IN POLYMERS. Vaisberg, S. E.; Sichkar, V. P.; Karpov, V. L. Vysokomol. Soedin., Ser. A; 13: No. 11, 2502-8 (Nov 1971). (In Russian).

The dependence of the radioinduced electric conductivity of high-pressure polyethylene (HPPE), low-pressure polyethylene (LPPE), polystyrene (PS), poly(methyl methacrylate) (PMMA), polycarbonate (PC), and two types of polytetrafluoroethylene (PTFE) on the dose rate j, and for HPPE, PS, and PTFE also on temperature T, was experimentally studied in a ^{60}Co field. In accordance with the Rose–Fowler model, the dependence $\sigma \sim j^{\Delta} \cdot 10^{\beta' T}$ is shown to be valid when the numerical values of the coefficients Δ and β' are correlated with the traps distribution parameter T_1 using the expressions $\Delta = T_1/(T_1 + T)$ and $\beta' = 19/(T_1 + T)$. Some temperature regions were found to deviate from this correlation. These temperature regions correspond to those of structural transitions. The results are interpreted assuming the electron traps to be associated with structure defects. (auth)

20949 ANOMALOUS ELECTRIC RESISTIVITY CHANGES OF GRAPHITE–BROMINE RESIDUE COMPOUND AT HIGH TEMPERATURE. Miyauchi, K.; Takahashi, Y.; Mukaibo, T. (Tokyo Univ.). Carbon; 9: No. 6, 807-8(Dec 1971).

The anomalous behavior observed in the thermal expansion of interlayer spacing of a graphite-bromine residue compound, at 330°C, was investigated by observing electrical conductivity changes of high-purity artificial graphite, between room temperature and 800°C. (UK)

20950 CALCULATION OF GRAPHITE CORROSION AND COOLANT COMPOSITION IN HELIUM COOLED HTRs. Hawtin, P.; Huber, R. A.; Wilmore, D. (Atomic Energy Research Establishment, Harwell, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 1, 71-9(Jan 1972).

In an HTR system small quantities of water vapor leaking into the He coolant corrode the graphite, yielding CO and H_2. Under reactor conditions the water gas shift reaction is likely to occur rapidly producing CO_2 which also corrodes the graphite. Since the rates of corrosion by water vapor and carbon dioxide are different, the shift reaction affects the shape of the corrosion profile. A steady state mathematical model for calculating the

graphite corrosion rate and the resulting coolant composition is described. The model assumes that the graphite is cylindrically symmetric, that the only method of transport of reactants and products into and out of the graphite is by diffusion and that the shift equilibrium is set up rapidly. A novel technique is used for solving numerically the resulting differential equations. As a special case, this technique may also be used for solving the equations for the model that describes the system when the shift reaction is assumed not to occur. A method was developed for incorporating this numerical procedure into a whole reactor calculation to determine a particular solution when the gas inlet composition is known. A computer program (RICHTER I) for carrying out this calculation is outlined. A simple method for generalizing this particular solution to an actual reactor situation is described. Calculations carried out in the absence of the shift reaction yield a parameter which is closely related to the integrated core reactivity by Everett et al. RICHTER, written in FORTRAN IV for the IBM System/360, calculates the rate of burn-off from the reactor core at a fixed instant in time, since the overall burn-off cannot be incremented within the program itself. Therefore such parameters as the diffusion coefficient and the reaction rate are assumed constant in time but not necessarily in space. (auth)

20951 MECHANISM OF ELECTROPLATING WITH BORON. Yukin, G. I. (All-Union Scientific-Research Inst. of Petroleum Machine Construction, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 13: No. 7-8, 662-4(Jul-Aug 1971).

Translated from Metalloved. Term. Obrab. Metal.; 13: No. 8, 42-5(Aug 1971).

Elementary boron cannot be deposited on the cathode as the result of the primary electrode process during electrolysis of molten borax, since in molten borates it enters into the composition of polyions—anions. The chemical mechanism proposed for electrolysis of molten borax conforms with modern concepts of the composition and structure of molten borates. The use of recent findings in the electrochemistry of molten salts to analyze processes observed in electrolytic boronizing explains the mechanism of this chemicothermal treatment. (auth)

20952 CHANGES IN PROPERTIES OF CARBON FIBRES DURING FAST NEUTRON IRRADIATION. Peggs, I. D. (Atomic Energy of Canada Ltd., Pinawa, Canada). Nature (London) Phys. Sci.; 235: No. 58, 112-13(7 Feb 1972).

Preliminary results are given for the irradiation of Types I and II, polyacrylonitrile(PAN)-based fibres, "Thornel 50S" fibres (Union Carbide), and pitch-based fibres. Irradiation was in the WR-1 organic-cooled reactor at 400 to 700°C, to fast neutron fluences up to 1.5×10^{21} n/cm^2 (E > 0.18 MeV). A structural degradation occurred, followed by an apparent recrystallization process; mechanical properties worsened and then improved, the extent of the changes being very temperature dependent. Changes in electrical conductivity are shown graphically; these followed very closely changes in the basal plane orientation parameter, Z_0, and confirmed the degradation/realignment process. Also shown graphically is the behavior of "lattice strain", as determined from a Hall plot of the characteristics of (002) and (004) x-ray reflections, against crystallite size; indications are that the strain increases with irradiation and then decreases, the turning point occurring at the same fluence as for other parameters. The process appears to be accelerated with increasing irradiation temperature. The dependence of crystallite size on "lattice strain" was very marked. Changes in fibre diameter with irradiation are also shown; type I fibres showed a relatively uniform expansion with irradiation, whereas type II show a contraction. It is thought that a partially graphitized PAN-based fibre may show ideal dimensional stability. Irradiations are being continued to higher fluences and the behavior at very low fluences is being examined. (UK)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

20953 (CONF-710617-(Vols.1 and 2)) INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT TWELFTH ANNUAL MEETING, JUNE 29-JULY 1, 1971. (Institute of Nuclear Materials Management, Columbus, Ohio). 801p. H. L. Toy, Columbus, Ohio $15.00.

Forty-one papers presented at the conference on nuclear materials management are included in these two volumes. A separate abstract was prepared for each of 3 papers. Thirty-eight papers appeared previously in NSA. For abstracts of these papers see CONF-710617-(Vol. 1 and 2) in the Report Number Index. (L.C.L.)

For abstracts of individual papers see: 20322, 20954, and 20955.

Accountability and Safeguards

Refer also to abstracts 20322 and 22205.

20954 (CONF-710617-(Vols.1 and 2), pp 71-9) CONTRIBUTIONS TO NATIONAL AND INTERNATIONAL SAFEGUARDS PROGRAMS BY INDEPENDENT TECHNICAL AUDITORS. George, Douglas E. (Nuclear Surveillance and Auditing Corp., Rockville, Md.).

From twelfth annual meeting of the Nuclear Materials Management; West Palm Beach, Fla. (29 Jun 1971).

The operation of nuclear power plants by utility companies requires that the utility buy yellowcake and retain title to the material throughout the fuel cycle while having possession of the material only at the reactor site. The "third party" auditing of nuclear material belonging to one party, i.e., the utility, but being processed, fabricated, or stored by another party has the advantages of protecting the investment of the utility and of providing additional information for safeguards purposes. The economic and safeguards benefits of having independent technical audits at each step throughout the fuel cycle are discussed. (L.C.L.)

20955 (CONF-710617-(Vols.1 and 2), pp 80-6) IMPACT OF NPT ON PRIVATE INDUSTRY. Haymon, David J. (Westinghouse Electric Corp., [Pittsburgh, Pa.] Nuclear Fuel Div.).

From twelfth annual meeting of the Nuclear Materials Management; West Palm Beach, Fla. (29 Jun 1971).

The international safeguards aspects of the Non-Proliferation Treaty and therefore the effects of the NPT on the activities of privately-owned commercial fuel processors in the US are discussed. (L.C.L.)

20956 USE OF A TRIGA REACTOR TO DETECT SMALL CONCENTRATIONS OF ^{239}Pu IN 55-GALLON DRUMS. Lukens, H. R.; Chesworth, R. H. (Gulf Energy and Environmental Systems, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 17(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

Disposal and Storage

Refer also to abstracts 20175, 20316, and 22204.

20957 (KURRI-TR-91) MANAGEMENT OF RADIOACTIVE LIQUID AND SOLID WASTES. II. Tsutsui, T.; Kanagawa, A.; Koyanaka, Y.; Shimoura, K.; Kimura, S.; Yokochi, A.; Nishimaki, K.; Tsukatani, T.; Kitagawa, I.; Oono, K.; Kan, I. (Kyoto Univ. (Japan). Research Reactor Inst.). Aug 1971. 8p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The radioactive waste treatment plant of the Research Reactor Institute, Kyoto University has been in operation since June 1964. In 1970, 1600m^3 of low- and very-low-level liquid wastes (10^{-5} to 10^{-8} $\mu Ci/cm^3$) and 4000 kg of solid wastes were produced as a result of the reactor operation and research. The management of radioactive liquid and solid wastes at the Research Reactor Institute, Kyoto University from April of 1969 to March of 1971 is reviewed. (auth)

20958 (WASH-1503) RADIOACTIVE WASTE REPOSITORY LYONS, KANSAS, Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Jun 1971. 236p. Dep. NTIS.

The June 1971 statement by the USAEC on the environmental impact of storing solidified high-level waste in a salt deposit at Lyons, Kansas is presented. Information is included on: radioactive waste characteristics; site selection; geologic, hydrologic, meteorologic, and ecologic characteristics of the site; potential impact on the environment from thermal and radiation effects; description of storage facility; impact on human environment; and economic and sociological impact on the locality. Alternatives to the proposed action are given. A 72-item bibliography of related reports is listed. An appendix containing 100 pages of correspondence to and from the USAEC related to this waste disposal proposal is included. (L.C.L.)

20959 (WASH-1503(Suppl.)) RADIOACTIVE WASTE REPOSITORY LYONS, KANSAS, Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Jul 1971. 103p. Dep. NTIS.

Supplementary material to the environmental statement on the radioactive waste repository at Lyons, Kansas is presented. This material, published in July 1971, is in the form of letters exchanged between AEC and Kansas state officials, newspaper articles and editorials, and geological survey reports. (L.C.L.)

20960 RADIOACTIVE WASTE MANAGEMENT IN ITALY. Branca, G. (CNEN, Rome); Gera, F.; Mirone, M.; Velona, F. Energ. Nucl. (Milan); 19: No. 1, 17-25(Jan 1972).

Current practices of radioactive waste management in Italy are described. Amounts of waste produced by the nuclear power industry, nuclear research centers, and radioisotope applications are estimated. The various methods of treatment for gaseous, liquid, and solid waste are reviewed. Waste disposal practices in Italy include release of gaseous and liquid effluents to the environment and on-site burial or sea dumping of solid waste. Changes in waste treatment practices are likely to include solidification of high-level liquid waste and advanced decontamination techniques for gaseous and liquid effluents. In relation to solid waste disposal the evolution of present management schemes will probably include the development of centralized burial grounds. A discussion follows on the evolution of waste management criteria as a consequence of the extremely long confinement time that will be required in the future by the increasing amount of transuranics contained in the waste. (auth)

20961 NEW RADWASTE RETENTION SYSTEM. Hogg, Roger M. (Babcock and Wilcox Co., Barberton, Ohio). Nucl. Eng. Int.; 17: No. 189, 98-9(Feb 1972).

A new method for handling gaseous wastes from nuclear plants by liquid-gas absorption, i.e., mainly of Kr and Xe isotopes, is described. It also provides for the disposal of solid and liquid wastes, and has proved effective in full-scale operating equipment. The problem of tritium is discussed, and tables are presented comparing gaseous and liquid waste discharges from BWR's and PWR's. (UK)

20962 CONFINEMENT OF RADIOACTIVE MATERIALS ACCORDING TO THE EXISTING LEGISLATION: INTERPRETATIVE AND APPLICATIVE PROBLEMS IN THE PRINCIPAL REGULATIONS OF THE D. P. R. No. 185 OF FEBRUARY 13, 1964, AND OF THE D. M. July 27, 1966. Nocera, F.; Zampini, F. (CNEN, Rome). Minerva Fisiconucl.; 14: No. 4, 186-9(Oct-Dec 1970). (In Italian).

Laws related to the storage of radioactive materials are now complete on the legislative level. Problems either of an interpretative or an applicative nature can arise in the framework of some health protection norms for enforcement, especially Article IX of the D.P.R. 13 of February 13, 1964, No. 185 and the D.M. of July 27, 1966. The most significant problems in this area are examined in the light of acquired experience. (tr-auth)

20963 NUCLEAR AND THERMAL WASTE POLLUTION. Preston, A. (Fisheries Lab., Lowestoft, Eng.). pp of Water Pollution as a World Problem: Legal, Scientific, and Political Aspects. London; Europa Publications (1971). (CONF-700722-2).

From Water pollution as a world problem conference; Aberystwyth, Wales (11 Jul 1970).

Among matters discussed were: basic standards for control of radioactive waste disposal (ICRP recommendations); part played by the IAEA (codes of practice); pattern followed by UK; parliamentary regulations; the Radioactive Substances Acts; disposal of waste from nuclear power stations, sites of the UKAEA, and other major users of atomic energy; authorisation by the Ministry of Housing and Local Government, the Ministry of Agriculture, Fisheries and Food, the Secretary of State for Scotland, and the N. Ireland Department of Commerce; the critical path method

of assessment; monitoring requirements; stage of radioactive waste; deep-sea disposal; and future requirements. (UK)

20964 NUCLEAR WASTE POLLUTION. Burhop, E. H. S. (London Univ.). pp 13-18 of Water Pollution as a World Problem: Legal, Scientific, and Political Aspects. London; Europa Publications (1971). (CONF-700722-1).

From Water pollution as a world problem conference; Aberystwyth, Wales (11 Jul 1970).

The emphasis was on the effects of industrial pollution by radioactive materials, and the comparative scale of such pollution was first discussed, followed by a short discussion on uptake of such materials by the body and the biological half-life and radiobiological damage effects. The work of international commissions on radiological protection was outlined. Present methods of storage and disposal of radioactive wastes were described, with emphasis on sea disposal. Uptake of radioactive materials by seaweed, and its implications, were discussed. The genetic hazards of radiation were outlined. The point was made that the benefits of applications of atomic energy should be weighed against the associated hazards. The way in which radioactive pollution is being dealt with was held to be a model for tackling other forms of pollution. (UK)

Handling Equipment and Procedures

20965 (LF-44, pp 7-13) PRODUCTION OF PLUTONIUM DIOXIDE AEROSOLS. Boyd, H. A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The toxicity of inhaled PuO_2 aerosols is of major interest and is the subject of ongoing research with experimental animals. Essential to the success of such studies is the availability of well-characterized PuO_2 aerosols that may be readily prepared in a reproducible manner as required for biological experimentation. A thermal degradation technique for producing aerosols of PuO_2 in the respirable size range was investigated. Aerosols were generated from aqueous systems using plutonium hydroxide, or Pu(III) and Pu(IV) in nitric, oxalic or hydrochloric acid. The aerosol was subsequently dried and thermally degraded by passage through a low temperature heating column followed by a high temperature heating column operating at temperatures up to 1150°C. The particles produced were separated by aerodynamic size and characterized according to shape and density. Conditions for the production of relatively spherical oxide particles of average density 10.5 gm/cm^3 are described. (auth)

20966 (LF-44, pp 14-19) PRODUCTION OF MONODISPERSE AEROSOLS OF $^{239}PuO_2$ FOR INHALATION EXPERIMENTS. Kotrappa, P.; Wilkinson, C. J. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

A method of preparing and aerosolizing monodisperse particles of $^{239}PuO_2$ is discussed. The process involves four steps: source aerosol preparation, centrifugal separation, resuspension and aerosolization. The procedure consists of generating an aerosol by nebulizing a solution of plutonium chloride, degrading the particles that are formed with a high temperature heating column to form a polydisperse aerosol of the oxide, separating and collecting these polydisperse particles into monodisperse aerodynamic size groups on a stainless steel collection foil in the Lovelace Aerosol Particle Separator (LAPS) and resuspending the monodisperse particles in water for future aerosolization by nebulization. (auth)

20967 (LF-44, pp 20-3) MEASUREMENT OF THE SPECIFIC RADIOACTIVITY WITH RESPECT TO PARTICLE SIZE FOR LABELED AEROSOLS. Kotrappa, P.; Wilkinson, C. J. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The functional relationship between the labeled radioactivity and particle size is an important characteristic of a labeled aerosol. Measurements were made of the specific activity of labeled fused clay aerosols using the following methods: dividing the aerosol into several narrow size groups using the Lovelace Aerosol Particle Separator; determining the radioactivity per particle by counting the number of particles and the radioactivity associated with a known area; determining a functional relationship between the relative radioactivity per particle and the particle size; and dividing a functional relationship thus obtained by the cube of the particle diameter. Fused clay aerosols labeled with ^{91}Y, $^{90}Sr-Y$, $^{144}Ce-Pr$, and $^{137}Cs-Ba$ had a cubic relationship between the relative radioactivity and particle size demonstrating that the specific activity is independent of particle size. Fused clay aerosol labeled with $^{106}Ru-Rh$ had a relationship other than cubic demonstrating a particle size dependence of specific activity, probably because of the volatility of Ru under heat treatment. (auth)

20968 (LF-44, pp 24-8) MEASUREMENT OF DENSITIES WITH RESPECT TO SIZE FOR SPHERICAL AEROSOLS. Kotrappa, P.; Wilkinson, C. J. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The Lovelace Aerosol Particle Separator was used to determine the density of aerosol particles by measuring the particle diameter and the associated aerodynamic diameter over an aerodynamic size range of 0.3 to 3.5 microns. The density of uranine aerosol was found to be 1.48 gm/cm^3 and was relatively constant with respect to size. The density of iron oxide aerosol was also relatively constant with respect to size and values ranging from 2.2 to 2.6 gm/cm^3 depending upon the starting material. Fused clay aerosols with various radioactive labels had a range of densities from 2.0 to 2.2 gm/cm^3 and the densities were independent of particle size. Densities of aerosols of cobalt and uranium oxides produced by heat degradation were observed to have a size dependence depending upon the starting material. The density of plutonium dioxide produced by thermal degradation of plutonium chloride was found to be independent of particle size for the range studied and had an average value $\sim 10.5 \pm 0.9$ gm/cm^3. (auth)

20969 (LF-44, pp 29-33) PREPARATION OF AEROSOLS OF COBALT OXIDES, CoO AND Co_3O_4 FOR INHALATION STUDIES. Kanapilly, G. M.; Newton, G. J. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

For the inhalation exposures of Beagle dogs to ^{60}Co oxides ($^{60}Co_3O_4$ and ^{60}CoO) aerosols with well-defined physical and chemical characteristics were required and experimental conditions for the production of these aerosols were investigated. For the generation of relatively dense and spherical particles, cobaltous nitrate solutions as the generator solution with predrying (between 60 and 70°C) of droplets before high temperature heat treatment were found to be suitable. The heat degradation of these aerosols at 850°C and 1450°C was adopted for the production of Co_3O_4 and CoO aerosol particles. (auth)

20970 (LF-44, pp 34-9) DEVELOPMENT OF AN IMPROVED SMALL ANIMAL EXPOSURE APPARATUS. Raabe, O. G.; Bennick, J. E.; Light, M. E.; Hobbs, C. H.; Thomas, Randi L.; Tillery, M. I. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

Studies of the disposition and toxicity of inhaled radioactive aerosols in small laboratory animals frequently are facilitated by the simultaneous exposure of numerous animals. A new apparatus for simultaneously exposing up to 88 rodents to highly radioactive aerosols is described. The animals are placed in specially designed and fabricated tubes to allow the exposure of only the nasal area of the head. The head ends of these tubes are inserted into exposure ports in the apparatus. An aerosol passes through a small hole in front of each animal's head so that each animal is exposed to a separate, fresh supply of the radioactive aerosol. Provision is made for aerosol generation, heat treatment of the aerosol if necessary, and sampling for aerosol characterization with a cascade impactor, a filter, and an electrostatic precipitator. Aerosol tests of the apparatus are described, including data on a test exposure on Syrian hamsters to fused clay with ^{90}Y. (auth)

20971 (LF-44, pp 40-50) DISSOLUTION OF ^{91}Y FUSED CLAY AND ^{90}Sr FUSED CLAY PARTICLES. Kanapilly, G. M.; Goh, C. H. T. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

The relative effects of particle size, temperature, method of measurement, solvent composition and the solvent flow rate on the in vitro rate of dissolution of monodisperse ^{91}Y-fused clay and narrow size group ^{90}Sr-fused particles were studied. In all the experiments the rates of dissolution were directly proportional to the reciprocal of diameter and significantly greater rates of dissolution at higher temperature were observed (up to 8% per °C). The method of measurement affected the observed rates of dissolution of ^{91}Y fused clay while it was not an important fact in the observed rates of dissolution of ^{90}Sr fused clay particles. The rate constant of specific solubility of fused clay

particles determined at 37°C in a parallel flow system (3.3×10^{-8} gm/cm^2/day) is in excellent agreement with the estimated in vivo rates of dissolution of fused clay particles in Beagle dog lungs after inhalation deposition. (auth)

Transportation

20972 (NYO-2539-6) STRUCTURAL INTEGRITY OF SHIPPING CONTAINERS FOR RADIOACTIVE MATERIALS. PART VII. EXPERIMENTAL STUDY OF PENETRATING IMPACT. Clarke, H. G. Jr. (Franklin Inst. Research Labs., Philadelphia, Pa.). Oct 1968. Contract AT(30-1)-2539. 168p. Dep. NTIS.

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20989 (LA-4824, pp 15-17) SPECIAL REQUIREMENTS FOR HRS BEAM MONITORING. Tanaka, Nobuyuki (Los Alamos Scientific Lab., N. Mex.). Nov 1971.

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Special beam monitoring problems posed by the High-resolution Proton Spectrometer and its beam analysis system are described. Monitoring of the beam position must be done without intercepting the beam. The beam dump of Beam Line C can probably be used to monitor beam intensity. During tune-up, precise tracing of particle trajectories by multiwire proportional chambers will be necessary. (1 figure, 1 table) (R.W.R.)

20990 (LA–4824, pp 19-23) DESIGN OF PRIMARY BEAM MEASURING DEVICES. Hornstra, Fred (National Accelerator Lab., Batavia, Ill.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

Some of the instruments designed to monitor the beam at the LAMPF experimental area and switchyard are briefly discussed. These include the beam centroid monitor, which derives a signal from the ionization of the residual gas by the traversing beam; the insertable strip ion chamber; the insertable secondary-emission profile monitor; the wire scanner profile monitor; and the high-resolution nonintercepting beam scanner. (4 figures) (R.W.R.)

20991 (LA–4824, pp 25-30) TOROIDAL CHARGE MONITORING SYSTEMS. Larsen, R. S. (Stanford Linear Accelerator Center, Calif.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The basic features of the toroidal charge monitors used at SLAC are briefly described, as well as a new system being developed for the Storage Ring (SPEAR). A primary beam measurement accuracy of ±0.1% is attainable. The feasibility of using systems at LAMPF is discussed. (6 figures) (R.W.R.)

20992 (LA–4824, pp 31) CURRENT MONITORING SYSTEM FOR H^- AND POLARIZED PROTON BEAMS AT LAMPF. Trump, Michael (Los Alamos Scientific Lab., N. Mex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The H^- and polarized-ion sources require a more sensitive system than the current transformer–amplifier combination developed for the main proton beam. A novel method for attaining the needed sensitivity is illustrated. The principal points are to reduce the number of secondary turns (to increase the sensitivity of the system) and to terminate the secondary winding in an extremely low impedance (to maintain a long time constant). (1 figure) (R.W.R.)

20993 (LA–4824, pp 33-9) INTENSITY MEASUREMENTS BY THE ACTIVATION METHOD: PROTON AND PION BEAMS. Steinberg, E. P. (Argonne National Lab., Ill.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

Foil activation techniques for beam monitoring are discussed. Excitation functions for 6 different proton reactions that are useful for intensity measurements by the activation method at high energies are given. The best foil for measuring pion beam intensities is ^{11}C. (7 figures, 1 table) (R.W.R.)

20994 (LA–4824, pp 41-2) PRELIMINARY DESIGN CONSIDERATIONS FOR AN 800-MeV PROTON-BEAM FARADAY CUP. Willard, H. B. (Case-Western Reserve Univ., Cleveland, Ohio); Riley, P. (Texas Univ., Austin). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

A preliminary design for a Faraday cup for 800-MeV protons is presented. Earlier attempts at constructing Faraday cups for protons in the range 100 to 800 MeV are reviewed. (1 figure) (R.W.R.)

20995 (LA–4824, pp 45-7) GENERAL PROBLEM OF PION BEAM MEASUREMENTS. Haddock, Roy P. (California Univ., Los Angeles). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

Some of the questions confronting a physicist proposing a pion experiment at LAMPF are discussed; the emphasis is on the determination of beam characteristics. (R.W.R.)

20996 (LA–4824, pp 55-8) PROFILE AND EMITTANCE MEASUREMENTS ON π BEAMS BY MEANS OF MWPC. Hungerford, E. V. (Rice Univ., Houston, Tex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The need for actual observation of beam properties during initial tune-up is pointed out. Multiwire proportional counters (MWPC's) can be conveniently used for this purpose, and a proposed method for making emittance and profile measurements on an LAMPF π channel is given. Pertinent specifications of the Rice MWPC are included. (4 figures) (R.W.R.)

20997 (LA–4824, pp 59-62) MONITORING PIONS WITH SCATTERING REACTIONS. Minehart, R. C. (Virginia Univ., Charlottesville). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The advantages of monitoring pions by elastic scattering by hydrogen are discussed. The design for a target of gaseous H_2 at 1 atmosphere about a meter long is given, and anticipated scattering rates are tabulated. The sensitivity to variations in beam parameters is investigated. The use of π–p scattering as a relative monitor of the pion content of the P^3 beam appears feasible. (6 figures, 2 tables) (R.W.R.)

20998 (LA–4824, pp 63-6) LOW INTENSITY MEASUREMENTS OF BEAM COMPOSITION. Minehart, R. C. (Virginia Univ., Charlottesville). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

At low energies particles can be identified by measuring momenta and some other kinematic quantity, such as range, total energy, or dE/dx; these methods become increasingly difficult above 100 MeV. For these higher energies it appears to be more promising to measure the difference in velocity for the various components in the beam. Time of flight is probably the simplest and most direct approach to measurement of velocity. To cover the region above 200 MeV, however, the best method seems to be use of Cherenkov counters; and two of these, the DISC (differential, isochronous, self-collimating, Cherenkov counter) and the "Long Cherenkov Counter," are discussed. Schemes that do not depend on a knowledge of the momentum are also included, such as identification of the pion through its decay. (3 tables) (R.W.R.)

20999 (LA–4824, pp 67-70) PION INTENSITY MEASUREMENTS BY THE DECAY METHOD. Mutchler, G. S. (Rice Univ., Houston, Tex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

A technique for measuring the pion flux in an impure beam without destroying the beam characteristics is described. A system of thin multiwire proportional chambers is used to detect the muons from the $\pi \rightarrow \mu + \nu$ decay. The experimental setup and data taken with this technique are shown. A monitor proposed for LAMPF is described which can measure beam profile, width, and divergence. (6 figures) (R.W.R.)

21000 (LA–4824, pp 77-81) USE OF THE $\pi \rightarrow e + \nu$ DECAY AS A PION BEAM MONITOR. McFarlane, W. K. (Temple Univ., Philadelphia, Pa.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The possibility of using the decay $\pi \rightarrow e + \nu$ as a pion beam monitor are discussed. The momentum of the electrons from this decay is appreciably higher than that of the electrons from muon decay. Approximate count-rate estimates are given; several different geometries are considered. A test of a similar arrangement at the PPA is briefly discussed. It is concluded that a monitor based on this decay is practicable, but it will have a fairly low count rate—one event for every 10^8 or 10^9 pions at the vertex. (9 figures) (R.W.R.)

21001 (LA–4824, pp 87-91) BEAM MONITORS FOR EPICS. Mayes, B. W. (Houston Univ., Tex.); McCarthy, J. S. (Virginia Univ., Charlottesville). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

Four primary systems to monitor the relative and absolute pion flux in the EPICS channel at LAMPF are considered. These are charge monitors (gas ionization chambers and secondary emission monitors), pion elastic scattering from hydrogen, $\pi \rightarrow \mu + \nu$ decay, and $\pi \rightarrow e + \nu$ decay. Advantages and difficulties associated with these methods are given. If the muon and electron contamination can be measured accurately, then charge monitors are one of the most reliable and simple systems to use. (2 figures, 5 tables) (R.W.R.)

21002 (LA–4824, pp 93-5) PLANNING FOR EARLY PION ACTIVATION MEASUREMENTS. Dropesky, Bruce J. (Los Alamos Scientific Lab., N. Mex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

It is pointed out that the activation foil beam monitoring technique must be used for both relative and absolute cross-section measurements in nuclear chemistry studies. To utilize the foil activation technique for monitoring the pion beam intensities at LAMPF, the excitation functions for a number of suitable monitor reactions will have to be accurately determined. These include the "primary" monitor, elastic scattering by carbon, and several "secondary" monitor reactions. Neutrons and, at higher energies, protons may be troublesome contaminants in the pion beam; suggestions are made to reduce their effects. (3 figures) (R.W.R.)

21003 (LA-4824, pp 97-101) PROBLEM OF MUON BEAM MEASUREMENTS AS DISTINCT FROM PION BEAMS. Thompson, P. A. (Los Alamos Scientific Lab., N. Mex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

Beam monitoring for the muon channel at LAMPF is reviewed. Particle fluxes at various points of the muon channel are tabulated. Ways of determining the rate and position of the final beam and its contamination are discussed; pions and muons can be separated by using Cherenkov counters, range curves, or time-of-flight measurements. Additional possibilities are available for negative beams. (6 figures, 2 tables) (R.W.R.)

21004 (LA-4824, pp 103-5) FEASIBILITY OF MUON INTENSITY MEASUREMENTS BY THE DECAY METHOD. Perkins, Roger B. (Los Alamos Scientific Lab., N. Mex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

A proposal is made to observe decay electrons from a muon beam as a means of monitoring the flux of muons in the beam. The use of such a device has the advantage that nothing must be placed in the beam itself. Possible applications include monitoring of muon fraction in a beam whose current can be measured by another technique, and monitoring of the muon flux in a beam which is stopped in an experimental target. (1 table) (auth)

21005 (LA-4824, pp 115-16) MONITORING PROBLEMS FOR NEUTRINO BEAMS. Burman, Robert L. (Los Alamos Scientific Lab., N. Mex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The main proton line beam dump at LAMPF will be a copious source of electron-neutrinos. Two methods to determine and monitor the neutrino flux are discussed. The first consists of a continuous monitor on the primary proton beam, for instance, a torroidal transformer or the spectrum of secondary particles. The second method consists of a measurement of the inverse beta decay of the neutron by using a deuterium target. (2 figures (R.W.R.)

21006 PROBLEMS OF RADIOPROTECTION AFTER INCREASE OF THE INTENSITY OF THE FRASCATI ELECTRO-SYNCHROTRON. Ladu, M.; Lucci, F.; Pelliccioni, M.; Roccella, M. (CNEN, Frascati, Italy). Minerva Fisiconucl.; 15: No. 2, 53-8(Apr-Jun 1971). (In Italian).

The substitution of the Van de Graaff injector by a 12-MeV microtron at the Frascatti electron synchrotron resulted in an increase of the intensity. The measurements of the radiation levels after the installation of the microtron in the absence and presence of the shielding toward the top consisting of a layer of concrete of 50 cm of thickness were reported. The other precautions adopted to resolve the principal radioprotection problems are briefly reviewed. (J.S.R.)

21007 MEASUREMENTS ON SUPERCONDUCTING HELICALLY-LOADED RESONATORS AT HIGH FIELD STRENGTHS. Fricke, J. L. (Kernforschungszentrum, Karlsruhe, Ger.); Piosczyk, B.; Vetter, J. E.; Klein, H. Particle Accel.; 3: No. 1, 35-41(Jan 1972).

A series of measurements on superconducting anodized niobium helices is described. Results for quality factors and maximum obtainable field strengths are presented and breakdown mechanisms are discussed. The best low field Q values at 1.9°K correspond to a surface resistance of 3.5×10^{-9} Ω at a frequency of 90 MHz. Peak electric fields of 24 MV/m and magnetic fields up to 640 G were measured in short pulse operation. In continuous operation, fields of 17 MV/m and 450 G could be obtained. Field emission increased the losses at high fields. (auth) (UK)

21008 SUPERCONDUCTING RF PARTICLE SEPARATOR. Bauer, W.; Dammertz, G.; Eschelbacher, H.; (and others) (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 173-81 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The concept and the expected performance figures of a superconducting rf particle separator for installation in the beam of the Omega detector system at the CERN Proton Synchrotron are described. (W.H.K.)

21009 TIME TAGGING THE PPA PROTON BEAM FOR ENERGY MEASUREMENT. Brody, H. (Univ. of Pennsylvania, Philadelphia); Groves, E.; Van Berg, R.; (and others). pp 759-60 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

In a search for neutral bosons using the $p + d \rightarrow {}^3He + x^0$ experiment, accurate determination of boson masses required precise knowledge of the proton energy. Since this energy changes by 7% during beam spill, a system was developed to measure, for each ^3He event, the instantaneous energy of the proton beam. The operation of this system is described. (R.W.R.)

21010 VERSATILE HIGH RESOLUTION BEAM POSITION MONITOR. Cummings, U.; Leith, D. W. G. S.; Williams, H. H. (Stanford Linear Accelerator Center, Calif.). pp 803-7 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A simple beam position monitor that uses the Cherenkov light generated by a charged particle in passing through a transparent dielectric was developed. A wedge-shaped gas cell presents a varying thickness of material to the beam particles depending on their position; hence, the amount of Cherenkov light produced is proportional to the beam position. This monitor is capable of measuring beam position to an accuracy of $\pm \frac{1}{2}$ mm over a range of 10^6 in beam current. This sensitivity is maintained down to a few nanoamperes. The total material presented to the beam is 0.3% radiation lengths; consequently, the multiple scattering is minimal. The counter can be readily interfaced with a digital computer for beam control. (2 figures) (R.W.R.)

Ion Sources, Injection, and Extraction

21011 (CEA-CONF-1871) IMPROVEMENT OF IMPLANTERS. DEFINITION OF STRUCTURES FOR SPECIFIC APPLICATIONS. Guernet, G.; Bernard, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 26 Jul 1971. 20p. (In French). (CONF-710932-2). Dep. NTIS (U. S. Sales Only).

From third international symposium on the application of vacuum techniques in semiconductor industry, electronic components, microelectronics; Versailles, France (13 Sep 1971).

After a discussion of the specific advantages of ion implantation, the characteristics which ion implanters designed for the fabrication of electronic components should have are described. The problems still unsolved for implanters presently under construction at the level of the structures of the target chambers and of the control of the implantation parameters (dose, energy, homogeneity) are presented. The definition of the structure of an implanter and necessary precisions are illustrated by the particular case of an implanter designed for the development of integrated circuits with MOS transistors. (7 figures, 1 table) (tr-auth)

21012 HEAVY ION ACCELERATION. Chabert, A. (Univ., Lyon); Sarazin, A. Bull. Inform. Sci. Tech. (Paris); No. 160, 11-15(Jun 1971). (In French).

Various coupled particle accelerator/multiply charged ion source systems are reviewed. Their performances are evaluated for the various experiments envisaged. (France)

21013 COUPLING OF A MULTICHARGED HEAVY ION SOURCE WITH AN ACCELERATOR. Oganesyan, Yu. Bull. Inform Sci. Tech. (Paris); No. 160, 17-21(Jun 1971). (In French).

Particle accelerators are classified according to the maximum energy they can impart to a nucleon. The desired characteristics of multiply charged heavy ion sources, envisaged for various purposes, are then stated. The number of particles produced and the repetition frequency are of special interest. The different sources are also examined from the points of view of charge, emittance, and energy spreading. Lasers appear to have promising applications in the development of high charge sources. (France)

21014 LASER PRODUCTION OF MULTIPLY CHARGED HEAVY IONS. Perez, A. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Bull. Inform. Sci. Tech. (Paris); No. 160, 39-49(Jun 1971). (In French).

Multiply charged ions were obtained by irradiating Be, C, Al, Fe, Cu, Mo Ag, Pt, Au and Pb targets. Charge collectors, electrostatic analyzers, etc., were used to investigate the principal features of ion emission: number of ions, energy spectra, and charge. A laser producing a flux of 10^{12}W/cm^2 produced C^{6+}, Al^{11+}, and Fe^{16+} ions with kinetic energies of more than 10 keV. The effect of the illumination and the nature of the target material are discussed. Experimental studies on the directivity of the plasma jet predict a high quality ion beam. (France)

21015 EXTRACTION OF HEAVY MULTIPLY CHARGED IONS PRODUCED BY A LASER. Faure, C. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Bull. Inform. Sci. Tech. (Paris); No. 160, 51-7(Jun 1971). (In French).

The directivity of the expanding plasma (spatial and energy distribution) allows the ions to be separated in space and time according to their charge. The main limitation to the ion extraction process is the dynamic space charge effect, which limits the number of extracted ions to 10^8 per pulse. However, with a repetition frequency of 1000 sec^{-1} (CO_2 laser), 10^{11} heavy multiply charged ions/sec can be injected into a heavy ion accelerator. (France)

21016 SOURCE OF MULTIPLY CHARGED IONS UTILIZING A LASER: POSSIBLE DEVELOPMENTS. Tonon, G. F. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Bull. Inform. Sci. Tech. (Paris); No. 160, 59-64(Jun 1971). (In French).

It is shown that in order to produce a sufficient quantity of U^{50+} ions, the product $\lambda^2\Phi$ must be greater than 2 10^{13} (Φ in W/cm^2, λ in μ). The high repetition rate required favors the use of a CO_2 laser. The characteristics that this kind of laser should possess are described. (France)

21017 STRIPPING IN CYCLOTRONS TO OBTAIN HIGH ENERGY HEAVY IONS. Bennett, J. R. J. (Rutherford High Energy Lab., Chilton, Eng.). Particle Accel.; 3: No. 1, 43-8 (Jan 1972).

The energy of heavy ions obtained from cyclotrons is severely limited by the charge states available from ion sources. By using harmonic acceleration and stripping the ion to a higher charge state during acceleration, the energy can be increased. Unfortunately this gives a beam which is extremely badly centered and results in very poor beam quality and low extraction efficiency. It is shown that the orbit centering problem can be overcome by using two strippers. Thus the energy range of existing cyclotrons can be simply extended for heavy ions. With a separated sector cyclotron the scheme could possibly be used to replace the expensive high terminal voltage tandem Van de Graaff injector, selected in many heavy ion proposals, by a much lower voltage injector. (auth) (UK)

Ion Optics and Field Calculations

21018 MOTION OF A CHARGED PARTICLE IN AN AXISYMMETRIC MAGNETIC FIELD. Srivastava, M. P.; Bhat, P. K. (Indian Inst. of Science, Bangalore). J. Phys. Soc. Jap.; 32: No. 3, 831-6(Mar 1972).

The motion of a single charged particle in an axially-symmetric magnetic field with a neutral point was studied. Treating the canonical angular momentum as a constant of motion, the motion was reduced to a two-dimensional one by introducing an effective potential and classified "off-axis", "encircling" and "hybrid" motions. Further, the guiding center of the particle was studied. One finds that it sticks to the leading magnetic lines of force and does not cross the Stoermer boundaries. The numerical computation of complete equations confirms the theory. However, the magnetic moment remains moderately adiabatic. (auth)

21019 ELECTRIC FOCUSING OF A CHARGED-PARTICLE FLUX WITH SPACE CHARGE. Volkov, B. I.; Sveshnikov, A. G.; Semashko, N. N. (Moscow State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1261-5(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1602-7(Aug 1971).

The stationary motion of an axially symmetrical flux of charged particles in the field of a single-gap electrostatic lens is studied taking account of the space charge; numerical methods are used. Curves representing the dependence of the phase diagrams of the beam at the exit section of the system on the retardation factor (ratio of the energy at entrance to the energy at exit) and current density are obtained. The results give a picture of the focusing properties of the lens, aberration properties of the flux, and the limiting values of the current density at the input. (auth)

21020 AXIAL BETATRON ACCELERATION OF A RELATIVISTIC RING OF CHARGED PARTICLES. Zakharov, V. S. (Vladimir Polytechnic Inst., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1296-8(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1647-50(Aug 1971).

The acceleration of a ring of charged particles in an inhomogeneous decreasing field superposed on a uniform time-varying magnetic field is examined. With this combination of fields it is possible to obtain an increase in the energy of charged particles for a constant ring radius. The stability conditions are found and the time-variation of the uniform magnetic field that keeps the radius constant is determined. The method makes it possible to do without the internal coils which are usually used with accelerated electron rings to maintain a constant radius. The method should be useful in collective linear ion accelerators. (auth)

21021 MAXIMUM ELECTRIC FIELD IN AN E_{01} IRIS-LOADED WAVEGUIDE. Zykov, A. I.; Kotov, V. I.; Kolot, Z. M.; (and others) (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1306-10(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1661-6(Aug 1971).

Using a perturbation method, the ratio of the maximum electric field in an iris-loaded waveguide to the accelerating field was measured. The values of R/Q in the range $a/b = 0.25-0.40$ for $\psi = \pi/2$, $2\pi/3$, and $3\pi/4$ modes for $\lambda_0 = 10.71$ cm and an iris thickness $t = 4$ mm ($t/\lambda_0 = 0.0374$) were also determined. (auth)

21022 RESONANCE OF COUPLED TRANSVERSE OSCILLATIONS IN TWO CIRCULAR BEAMS. Koshkarev, D. G.; Zenkevich, P. R. (Inst. of Theoretical and Experimental Physics, Moscow). Particle Accel.; 3: No. 1, 1-9(Jan 1972).

It is shown that in a system of two circular beams there exist resonances analogous to the well-known resonances produced by external perturbations in circular beams of singly charged particles. The general resonance condition is $nQ_1 = mQ_2 = k$ where Q_1 and Q_2 represent the natural oscillation frequencies of the particles in the first and second beams, and m, n, and k are integers. Equations are derived for the resonance bandwidth and for a resonance of any order, and the crossing of resonances is investigated. Analysis of these results shows that the two-beam interactions impose a strict upper limit on the frequencies of the self-stabilizing Bennet–Budker beam. (auth) (UK)

21023 LONGITUDINAL STABILITY OF A COASTING BEAM IN A CORRUGATED RESISTIVE VACUUM CHAMBER. Keil, E.; Zotter, B. (CERN, Geneva). Particle Accel.; 3: No. 1, 11-20 (Jan 1972).

An analysis is made of the electromagnetic fields excited by longitudinal density fluctuations of an unbunched, relativistic particle beam drifting in a corrugated vacuum chamber of circular cross section. From these fields the coupling impedance is calculated, which is a measure of the reaction of an oscillating beam upon itself, and determines its stability. The coupling impedances of bellows and cross-section variations are investigated as functions of various geometric and beam parameters. Corrugations of a vacuum chamber may become resonant cavities at higher frequencies. The coupling impedance (divided by the mode number) may become several orders of magnitude larger than its value at lower frequencies, and severely endanger beam stability. The resonant coupling impedances can be found directly by computer solution of the matrix equations for the field coefficients. (auth) (UK)

21024 THEORY OF SYNCHROTRON MOTION NEAR TRANSITION ENERGY IN AN AGS. Herrera, J. C. (Brookhaven National Lab., Upton, N. Y.). Particle Accel.; 3: No. 1, 49-53(Jan 1972).

The basic equations for small-amplitude synchrotron oscillations are put into matrix form. Using this matrix formulation, the dynamics of a particle in the region of the transition energy is studied and the transformation matrix and the phase-space invariant characterizing the particle motion are derived. The corresponding maximum phase excursion and the maximum fractional momentum deviation are calculated. (auth) (UK)

21025 MICROWAVE EMISSION PRODUCED BY THE INTERACTION OF AN INTENSE RELATIVISTIC ELECTRON BEAM WITH A SPATIALLY MODULATED MAGNETIC FIELD. Friedman, M.; Herndon, M. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 28: No. 4, 210-13(24 Jan 1972).

Intense microwave emission was detected when a pulsed relativistic electron beam traversed a spatially modulated magnetic field. The microwave intensity was $\gtrsim$70 dB above the noise level.

The wavelength of the electromagnetic radiation was equal to the characteristic length of the rippled magnetic field. At a critical averaged magnetic field, the radiation appeared to be almost monochromatic ($\Delta\lambda/\lambda \lesssim 0.5\%$); below the critical field, a broad spectrum appeared ($\Delta\lambda/\lambda \gtrsim 10\%$). (auth)

21026 METHOD OF CORRECTING FRINGING FIELDS OF MAGNETIC DEFLECTION SYSTEMS. Akiba, Toshimitsu (Mitsubishi Electric Corp., Amagasaki, Japan). Jap. J. Appl. Phys.; 11: No. 2, 224-36(Feb 1972).

A method for designing a magnet system is described, in which the effects due to extended fringing fields are considered. Equations for describing the magnet system are obtained by employing the effective transfer coefficients, which are expressed in terms of Penner's coefficients for the magnet and the changes in the vertical edge focusings at the entry and exit. The resulting trajectories, the momentum dispersion and other important properties of the system are calculated by making use of the matrices which consist of the parameters obtained by solving the equations. Displacements of the central ray at the entry and exit depend complicatedly on the entry and exit angle, the radius of curvature of the ray and the air-gap between the poles. It is concluded that a symmetrical system is preferable. (auth)

Storage Rings

Refer also to abstract 21359.

21027 (USIP-71-11) RELATIVISTIC KINEMATICS FOR STORAGE RINGS. Carlson, P. J.; Leistam, O. (Stockholm Univ. (Sweden). Inst. of Physics). Dec 1971. 12p. Dep. NTIS (U. S. Sales Only).

The special features of the relativistic transformations appropriate to the CERN intersecting storage rings (ISR), where two proton beams are made to collide at an angle of 15° are dealt with. The appropriate transformation equations are given. (Sweden)

21028 DUAL SEAL BAKEABLE SECTOR VALVES OF THE CERN INTERSECTING STORAGE RING. Bachler, W. (Leybold-Heraeus, Cologne); Wikberg, T. Vacuum; 21: No. 10, 457-9 (Oct 1971).

For the large proton intersecting storage ring (ISR) at CERN, valves were required so that the various sections of the ring chamber could be isolated. It was found that the requirements to be met by such valves, which are enumerated, were best realized by all metal dual-seal valves with an intermediate guard vacuum. An experimental valve, which had a leak rate $<10^{-9}$ torr l/sec even when baked to 300°C and repeatedly actuated, is described and illustrated. The prototype design which followed, identical to the valve now in use on the ISR, is also shown and discussed. The gate valve consists of a pendulum with a bellows seal and a special mechanism to obtain the required closing time of <1 sec. (UK)

21029 PHYSICAL PROCESSES IN HADRON AND LEPTON MIGMA. Maglic, Bogdan (Rutgers-The State Univ., New Brunswick, N. J.). pp 13-42 of Invited Papers. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

Particle interactions in self-colliding orbits such as those produced in a Precetron are discussed for hadron and lepton migmas. Migma is a mixture of precessing orbits of particles of different momenta, different directions, and possibly different charges, masses and lifetimes. Luminosities, interaction rates, and merging beam rates for a 10 cm, 400 k gauss Precetron are presented. (L.B.S.)

Experimental Facilities

Refer also to abstracts 20429, 20508, 20982, 20987, 21358, and 21661.

21030 (IAE-2019) SELECTION AND OPTIMIZATION OF MODERATORS FOR PULSED SOURCES OF SLOW NEUTRONS. Ishmaev, S. N.; Sadikov, I. P.; Chernyshov, A. A. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 40p. (In Russian). Dep. NTIS (U. S. Sales Only).

The neutron-physical requirements on moderators designed for production of intense pulsed fluxes of slow neutrons with the IAE linear accelerator with booster were examined. The results of the experimental study for the optimization of the hydrogen-containing moderator were presented. By use of a crystal spectrometer on the linear accelerator the dependence of the flux of neutrons of different energies on the time for different moderating compositions based on $(CH_2)_n$ and H_2O was measured. The effects of geometry, thickness, and temperature of the moderator, supplementary absorption, and use of reflecting filters on the intensity and duration of the pulse of monochromatic neutrons were investigated. (tr-auth)

21031 (INR-1287) PULSE RADIOLYSIS INSTRUMENTATION OF THE LAE 13-9 LINEAR ELECTRON ACCELERATOR. Zagorski, Z. P.; Zimek, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 9p. INIS.

Basic features of the electron linear accelerator LAE 13-9 are described. A pulse radiolysis measuring system has been developed for the study of intermediate kinetics. The system is based on the absorption of an external or internal source of analytical light. First results of measurements performed during the pulse of electrons are gained using Cherenkov light as the internal source. (auth) (INIS)

21032 (LA-4824, pp 107-14) NEUTRON FLUX AND SPECTRAL MEASUREMENTS IN THE MEDIUM ENERGY RANGE. Morgan, I. L. (Texas Univ., Austin). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The present state of knowledge of the n-p cross section and its relevance for neutron flux and spectral measurements in the medium-energy range are discussed. In general, the most widely employed neutron detector for flux measurement and/or monitoring, as well as crude energy distribution measurements, is the differential range proton recoil telescope. Other experimental apparatus and methods are considered, including time of flight and magnetic energy analysis. The problem of background is discussed, but a lack of knowledge of the source at present precludes an accurate estimate of the background. (11 figures, 1 table) (R.W.R.)

21033 (LA-4824, pp 185-9) LAMPF DATA-ACQUISITION SYSTEM. Butler, H. S.; Biswell, L. R.; Machen, D. R.; Thomas, R. F. (Los Alamos Scientific Lab., N. Mex.). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

A status report on the LAMPF data acquisition system is given. Small digital computers will be dedicated to each experiment, with a data link between the LAMPF and the Central Computing Facility (CCF). CAMAC was adopted as the standard for interfacing experimental apparatus to each computer. Computer hardware, PDP-11 software, and the CAMAC interface are discussed. The computer network being developed at the LASL CCF is described. The basic tenet of control philosophy for the beam-line equipment is that the switchyard, the primary beam lines, and the permanent parts of the secondary beam lines will be controlled from a central point in order to ensure that the consequences of a parameter change affecting more than one experimenter are considered before the change is made. (R.W.R.)

21034 COMPUTER-CONTROLLED 70-IN. CHAMBER. Yntema, J. L. (Argonne National Lab., Ill.). pp 74-7 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

A computer-controlled 70-inch radiation target chamber is described. The computer controls the detector and target positions, selects from various standard sources, and controls the electromagnetic fields in the chamber. In addition, the computer collects and allows access to the data during an experiment. A block diagram of the system is presented. (J.W.R.)

21035 TARGET FOR NINA. Herbert, S. Ind. Diamond Rev.; 54-7(Feb 1972).

Design details of the National Institutes Northern Accelerator (NINA) are given. Gem quality industrial diamonds have recently been introduced as targets for the high energy electron beam for use in experiments to determine the internal structure of the proton. The advantage of a diamond target over a tungsten one is that if it is mounted accurately in a goniometer so that the diamond crystal lattice can be orientated accurately with respect to the incoming electron beam then the continuous spectrum obtained from a tungsten target is dramatically modified into one with sharp pikes (enhancement spikes). Also the γ rays in the spikes are highly polarized in a plane determined by the crystal orientation and these polarization properties are utilized in determination of internal structures. The type of stone selected for the work is discussed and the design of the target manipulator used for the accurate positioning of the stone is considered. (UK)

21036 CONTINUOUS FLOW HORIZONTAL ^{3}He CRYOSTAT FOR ORGANIC POLARIZED PROTON TARGETS. Robeau, P. (CEN de Saclay, Gif-sur-Yvette, France) Vermeulen, J. Cryogenics; 11: No. 6, 478-82(Dec 1971).

Organic target materials show advantages over LMN including a higher density of free protons and a considerably better ratio of free to bound protons. If the temperature of operation is reduced to be within the 0.5 to 1.0°K range, polarization is improved from about 36% to about 80%. Initially, experiments were carried out with small samples; but a cryostat is described for a commonly used target size of 5 to 15 cm^3. Temperature measurement and operation and performance of the cryostat are discussed. (UK)

21037 PROTON SCATTERING BY PROTONS AND NUCLEI IN THE INTERNAL BEAM OF AN ACCELERATOR USING A GAS TARGET. Bartenev, V. D.; Belushkina, A. A.; Valevich, V. I.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). pp 16-25 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

For the investigation of elastic proton scattering by protons and nuclei a thin polyethylene film target made possible the measurement of the angle of inclination of the differential p-p and p-d scattering. A gaseous hydrogen target was also employed with the accelerator beam. Semiconductor detectors and spectrometric equipment fed the desired information to a computer. The differential p-p scattering cross section was measured at 70 GeV. With the aid of the gaseous target the differential elastic p-p and p-d cross sections were measured at small angles in the energy range 8 to 70 GeV. (K.S.W.)

21038 METHODS FOR SEARCHING FOR MAGNETIC CHARGES USING HIGH-ENERGY ACCELERATORS. Zrelov, V. P.; Kollarova, L.; Kollar, D.; (and others). (Joint Inst. for Nuclear Research, Dubna, USSR). pp 479-81 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Equipment was designed for making a search for Dirac's monopole in the internal beam of the 70-GeV proton synchrotron. A proton beam is aimed at a target of optical quartz. Vavilov–Cherenkov radiation originates in the target and is emitted through windows of the accelerator. Discrimination of charged particles according to the polarized Vavilov–Cherenkov radiation may be enhanced through use of a supplementary analyzer, based on a difference in the reflecting ability of light of different polarizations from the glass surface close to Brewster's angle. (1 figure) (K.S.W.)

21039 ADVANCES IN POLARIZED TARGET DESIGN. Neganov, B. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 575-84 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Recent achievements in the field of polarized targets are reviewed. New working substances were tried: ethylene glycol and butanol. The degree of polarization of the hydrogen lay between 35 and 65%, depending on the cryogenic technology employed. Target weight was raised to 21 g. Experimentalists may now change the direction of polarization during an interval of 5 to 10 s, and pass up to 10^{14} charged particles through a target in a single experiment. Other advances are mentioned and identified as to worker and laboratory. (23 references, 6 figures) (K.S.W.)

21040 METHOD OF MEASUREMENT OF POLARIZATION OF A POLARIZED PROTON TARGET. Kovalev, A. I.; Prokof'ev, A. N.; Shklyarevskii, G. M. (Ioffe Inst. of Physics and Tech., Leningrad). pp 585-7 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The extent of proton polarization in a polarized target is an integral function of the magnetic susceptibility of the target material. This integral function was measured experimentally by a technique which was free of the difficulties which arise during compensation for the impedance in the measuring circuit. Because modulation of the magnetic field did not generate interference, the signal was readily isolated from the background employing the instrumentation described. (2 figures) (K.S.W.)

21041 POLARIZED ^{3}He TARGET FOR HIGH ENERGY SCATTERING EXPERIMENTS. Daniels, J. M.; Kirkby, P.; May, A. D.; Timsit, R. S. (Univ. of Toronto). pp 588-90 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Polarized ^{3}He makes an attractive polarized target because it can be polarized in the elemental state, and thus all the neutrons in the target are in principle polarizable. For experiments at high energies, therefore, it may be regarded as one-third polarized neutrons and two-thirds unpolarized protons. A system is described in which ^{3}He is polarized at a pressure of 1 torr by optical pumping and then compressed into a target cell located in a very homogeneous magnetic field (which results in a long relaxation time for the ^{3}He polarization). Thus far, a pressure of 217 torr has been attained in the cell, and a pressure of 1 atm seems feasible. (R.W.R.)

21042 ^{3}He-COOLED POLARIZED TARGETS. Vermeulen, J. (CERN, Geneva). pp 591-4 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The development of polarization in solidified alcohols has provided targets containing twice as many polarized protons and 1/5 as many bound protons (which result in background) as the previously used LMN crystals. Such targets in use at CERN are very briefly described; the bulk of the articles discusses the ^{3}He cryostat. (1 figure, 1 table) (R.W.R.)

21043 PERFORMANCE OF ETHYLENE GLYCOL POLARIZED TARGETS AT ARGONNE NATIONAL LABORATORY. Hill, D.; Masaike, A.; Yokosawa, A. (Argonne National Lab., Ill.). pp 595-9 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Work at ANL with ethylene glycol as a polarized proton target material is summarized; glycol was used because it can sustain a slightly higher polarization than a butanol–water mixture. The cryostat used and the preparation of eight targets are described; the average dynamic polarization of all 8 was 38.2%. The effect of adding water to the glycol in target preparation was also investigated. This process improved the polarization for up to 2 to 3% water content. Bubbling nitrogen gas through the mixture gave a slight improvement in polarization. In this way a maximum polarization of 48% was obtained at a temperature of 1.06°K. (1 figure) (R.W.R.)

21044 HYPERON BEAMS. Sandweiss, J. (Yale Univ., New Haven). pp 717-24 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The production and use of high-energy hyperon beams at proton accelerators is discussed; special attention is directed to the problem of muon shielding. Flux estimates for Σ^-, Ξ^-, and Ω^- hyperons produced by 30-GeV/c protons are determined. Detectors used in hyperon beam experiments are of two types: those placed in the beam itself for particle identification or measurement and those used to detect the products of hyperon decay or interaction. Several in-beam detectors are described. Hyperon experiments at the AGS and at CERN are reported. (3 figures) (R.W.R.)

21045 DESIGN AND USE OF A SHORT-LIVED NEUTRAL BEAM FOR THE NAL ACCELERATOR. March, R. H.; Pondrom, L. G. (Univ. of Wisconsin, Madison). pp 725-30 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A neutral beam for which the hadronic shield is combined with the sweeping magnet can be used to work within 10m of a target; thus, Λ^0, $\equiv^0$, and K^0 decays can be studied in the 100 to 200 GeV

region. A detector is described which will measure the relative intensities of the various components of the beam. The same apparatus will also perform a search for the $\Delta S = 2$ decay $\Xi^0 \rightarrow p\pi^-$ at the level 10^{-6} and will measure Λ^0 and $\bar{\Lambda}^0$ total and diffraction cross sections in hydrogen. (2 figures, 1 table) (auth)

21046 PRODUCTION OF AN INITIALLY PURE K^0 BEAM OF KNOWN MOMENTUM. Aubert, J. J. (CERN, Geneva); Niebergall, F.; Stier, H. E. pp 731-3 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The reaction $K^+ + p \rightarrow K^0 + p + \pi^+$ was used to generate a beam of neutral kaons in an initially pure state of defined strangeness. The full kinematics of this reaction is observed in the study of three-body decays of neutral kaons. An apparatus to detect decays of neutral kaons in the first eight K_S lifetimes was built. The performance of the apparatus was studied by using a sample of neutral kaon events produced as above and decaying into two charged pions, and the results of these studies are shown. (2 figures) (R.W.R.)

21047 TAGGED PHOTON BEAMS FOR VERY HIGH ENERGY. Morrison, R. J. (Univ. of California, Santa Barbara); Caldwell, D. O.; Elings, V. B. (and others). pp 734-7 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The need for tagged photon beams is discussed; and a system used at SLAC, in which only 0.3% of the tagging signals were not accompanied by proper photons, is described. (2 figures) (R.W.R.)

21048 QUASI-MONOCHROMATIC POLARIZED PHOTON BEAM FROM THE PHYSICAL-TECHNICAL INSTITUTE 2-GeV LINEAR ELECTRON ACCELERATOR. Gorbenko, V. G.; Zhebrovskii, Yu. V.; Kolesnikov, L. Ya.; (and others) (Physical-Technical Inst., Kharkov). pp 738-45 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A quasi-monochromatic polarized beam of γ quanta was obtained by a method using coherent bremsstrahlung in a diamond crystal radiator for the purpose of studying photo-produced elementary particles in a linear electron accelerator with a maximum energy of 2 GeV. Charged particles were removed from the γ-quanta beam with a magnet, which also functioned as a spectrometer for secondary electrons. The yields of various elementary particles were determined as functions of the angle of orientation of the crystal. (K.S.W.)

21049 QUASI-MONOCHROMATIC POLARIZED PHOTON BEAM FROM THE EREVAN ACCELERATOR. Avakyan, R. O.; Armaganyan, A. A.; Arutyunyan, L. G.; (and others) (Erevan Physics Inst.). pp 746-52 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The coherent bremsstrahlung from 4.5-GeV electrons in the Erevan accelerator was studied. The electrons which were circulating in the accelerator ring were directed into a diamond target. The photon intensity was measured as a function of the angle of rotation of the crystal. The bremsstrahlung spectrum from diamond was improved, and the photon polarization was increased. (K.S.W.)

21050 SHAPING CHARACTERISTICS OF HIGH-ENERGY GAMMA-QUANTA BEAMS AND USE OF THE PHOTOEMULSION METHOD AT ELECTRON ACCELERATORS IN THE GeV RANGE. Grishaev, I. A.; Lapin, N. I.; Nikiforov, V. I.; (and others) (Physical-Technical Inst., Kharkov). pp 753-8 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Inferences are drawn from experiments on the formation and shaping of high energy γ-quanta beams from a 2-GeV electron accelerator which utilize a radiator, separating magnets, a vacuum duct, and appropriate shielding. The methodology described for beam shaping results in a low background, which in turn permits the use of a photoemulsion technique for investigating photoproduction of pions on nuclei and other processes with cross sections of $\sim 10^{-30}$ cm^2. (K.S.W.)

21051 NEUTRINO FOCUSING SYSTEMS: PAST, PRESENT, AND FUTURE. Nezrick, F. A.; Carey, D. C.; Kang, Y. W.; Stefanski, R. J. (National Accelerator Lab., Batavia, Ill.). pp 826-39 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

Conventional neutrino beams are obtained from two-body decays in flight of intense meson beams. The neutrino flux passing through a finite detector is enhanced by directing (focusing) the mesons toward the detector. A neutrino beam line is composed of a target yielding an intense meson flux, a focusing region, a meson decay region, a filter to absorb the muons produced in π and K meson decay, and a detector region. The subject of this paper is the various devices used to direct the mesons toward the detector. The desired features of an ideal focusing system are listed. The following focusing systems are discussed: no focusing, horn focusing, plasma lenses, finger focusing, multiple horn systems, fish focusing, broad band quadrupole channels, and narrow band quadrupole beams. (5 figures, 1 table) (R.W.R.)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 21360, 21366, and 21367.

21052 COSMIC GAMMA RADIATION IN THE 0.3 TO 3.7 MeV RANGE. Golenetskii, S. V.; Mazets, E. P. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 14: No. 4, 131-4(20 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 4, 201-5(20 Aug 1971).

Measurements of γ radiation of medium and low energy, performed on low-flying satellites in a wide range of geomagnetic coordinates, makes it possible in principle to obtain accurate estimates of the flux of cosmic diffuse γ radiation and its contribution to the total γ flux measured near the Earth. An analysis of the data obtained with Kosmos-135 and -163 is presented. The measurements were made with a 64-channel γ spectrometer. The detector was an NaI(Tl) crystal (40 mm × 40 mm), surrounded by a plastic scintillator to shield it against the charged particles. (W.D.M.)

21053 FORBUSH DECREASES IN THE COSMIC RADIATION. Lockwood, John A. (Univ. of New Hampshire, Durham). Space Sci. Rev.; 12: No. 5, 658-715(Dec 1971).

The experimental observations of Forbush decreases in recent years are reviewed and related to different theoretical models which have been proposed. The observational data from both ground-based and spacecraft experiments were selected to illustrate the important characteristics of Forbush decreases. The form of the rigidity dependence of the cosmic-ray modulation during the decreases and effects of the geomagnetic field upon the magnitude of the decreases are discussed. Recent results to deduce the cosmic-ray flow patterns from the observed anisotropies during the decreases are presented. Other features such as differences in onset times, recovery times, and precursory increases are discussed. In considering the theoretical models particular emphasis is placed upon the agreement of the predictions of the model with the experimental observations. A theoretical model is suggested which is not original but represents a synthesis of several models previously proposed. Future important measurements and analyses necessary to understanding of Forbush decreases are outlined. 115 references. (auth)

21054 FOKKER–PLANCK EQUATIONS FOR CHARGED-PARTICLE TRANSPORT IN RANDOM FIELDS. Jokipii, J. R. (California Inst. of Tech., Pasadena). Astrophys. J.; 172: No. 2, 319-26(1 Mar 1972).

The Fokker–Planck equations for charged-particle dynamics are rederived, extending somewhat the elegant discussion of Hasselmann and Wibberenz. It is shown that the usual results are obtained and the conclusions in many cases are correct over a very broad range in energy. In particular, the rate for pitch-angle scattering (and hence $\kappa_{||}$) may be accurately given down to energies much lower than previously thought. Recent claims that these Fokker–Planck equations are in general incorrect are thus shown to be in error. (auth)

21055 MEASUREMENT OF HIGH-ENERGY γ-QUANTUM FLUXES IN PRIMARY COSMIC RAYS ON THE COSMOS-208 SATELLITE. Bratolyubova-Tsulukidze, L. S.; Grigorov, N. L.; Kalinkin, L. F.; (and others) (Moscow State Univ. Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 499-502(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 585-9(1971).

Cosmos 208 measured the intensity of γ quanta with energies $\geq$30 MeV. The count rates of γ quanta and of charged particles depended similarly on geomagnetic latitude. (auth)

21056 HIGH ENERGY GAMMA RADIATION FROM THE REGION OF CYGNUS–CASSIOPEIA. Browning, R.; Ramsden, D.; Wright, P. J. (Univ. of Southampton, Eng.). Nature (London) Phys. Sci.; 235: No. 59, 128-30(14 Feb 1972).

Data obtained in earlier observations are first briefly reviewed; these yielded conflicting results. Results obtained with a balloon borne γ-ray telescope flown from Palestine, Texas, on September 23/24, 1970 are then presented; the chief object of this flight was to study γ radiation of energy >100 MeV from the direction of the galactic plane in the region of Cygnus and Cassiopeia. The apparatus comprised an optical spark chamber of area 2,500 cm^2 triggered by a counter telescope, the track of each event in the spark chamber being recorded on film by a system of mirrors. A digital display was mounted alongside the spark chamber, and the method of data analysis is described. Several regions where possible point sources of γ radiation might exist were indicated, and the strengths of these sources were estimated, together with their positions. A search was also made for evidence of a diffuse emission associated with the galactic plane. Although there seemed to be an excess of γ radiation at high galactic latitudes, no such emission was found within ±2° of the galactic plane. If the point sources are genuine, the apparent line source associated with the galactic plane would be 1.3×10^{-4} photons 1 cm^2 s rad. (UK)

21057 COSMIC GAMMA RADIATION. Gal'per, A. M.; Kurillov-Ugryumov, V. G.; Luchkov, B. I.; Prilutskii, O. F. Usp. Fiz. Nauk; 105: No. 2, 209-50(1971). (In Russian).

Eight basic processes for the generation of cosmic γ radiation are reviewed, and available literature on γ telescopes and similar techniques for recording cosmic rays is summarized. The difficulties with atmospheric and local background interference with cosmic radiation measurement and with balloon use are described. Other topics include galactic anisotropic streams of diffuse cosmic gamma radiation, the search for discrete sources of cosmic rays, and the discovery of γ radiation in the Crab Nebula, the Sun, and extragalactic regions. Advances in intrepretation of data from these sources are detailed, and trends in the future of cosmic-ray investigation are discussed. 299 references. (K.S.W.)

21058 EXTINCT SUPERHEAVY ELEMENT IN METEORITES: ATTEMPTED CHARACTERIZATION. Anders, Edward (Univ. of Chicago); Larimer, John W. Contract AT(11-1)-382. Science; 175: No. 4025, 981-3(3 Mar 1972).

If the unexplained fission-xenon component in meteorites is due to a volatile superheavy element, this element must have had a heat of vaporization of 54 ± 3 kcal per mole and a normal boiling point of 2500° ± 400°K. The prime candidates are elements 111 and 115, followed by 113, 114, 112, and 116. Elements 105 to 110 are not volatile enough and can therefore be excluded. (auth)

21059 COSMIC-RAY SPECTRAL MODULATION ABOVE 2 GV DURING THE DESCENDING PHASE OF SOLAR CYCLE NUMBER 19. I. A COMPRESHENSIVE TREATMENT OF THE NEUTRON MONITOR DATA FROM THE WORLDWIDE STATION NETWORK AND LATITUDE SURVEYS. Bachelet, F. (Univ., Rome. CNR, Rome); Iucci, N.; Villoresi, G.; Sporre, B. Nuovo Cim.; 7B: No. 1, 17-33(11 Jan 1972).

This is the first of a series of three papers meant to study the short- and long-term spectral modulation of primary cosmic rays above 2 GV during the time from the IGY to the IQSY, for a large part of solar cycle No. 19, which showed the highest activity recorded so far, and a complex superposition of different kinds of conspicuous solar-induced interplanetary perturbations. In Part I the information on the modulation as gained by means of neutron monitor data is presented. The information covers a fair primary rigidity range and offers a time and rigidity resolution that is not reached by other experimental data. Also presented and applied to the 1957–65 data is an indirect calibration procedure for practically the whole network of the near-sea-level neutron monitors by means of seven latitude surveys performed by ship or by terrestrial vehicle. The procedure provides a set of daily latitude curves suitable for directly deriving the isotropic variation of the primary differential spectrum. (auth)

21060 COSMIC-RAY SPECTRAL MODULATION ABOVE 2 GV DURING THE DESCENDING PHASE OF SOLAR CYCLE NUMBER 19. II. A STUDY OF LARGE FORBUSH DECREASES. Bachelet, F.; Iucci, N.; Villoresi, G. (Univ., Rome. CNR, Rome). Nuovo Cim.; 7B: No. 1, 34-44(11 Jan 1972).

The daily sea-level latitude curves obtained as described in Part I are used to derive the isotropic primary spectral variation during 14 large Forbush decreases between July 1957 and December 1965. The criteria adopted to attain a satisfactory accuracy in the modulation amplitude and to avoid the spurious or anisotropic effects are reported. Due to the high precision and good rigidity coverage of the data used, detailed information on the modulation function in the studied rigidity region is reached for the first time. The Forbush decrease modulation shows a fairly constant behavior throughout the solar cycle, with an indication, present in the individual events and emerging clearly in the average function, of a change in slope in the 5- to 10-GV region. (auth)

21061 COSMIC-RAY SPECTRAL MODULATION ABOVE 2 GV DURING THE DESCENDING PHASE OF SOLAR CYCLE

NUMBER 19. III. A STUDY OF THE LONG-TERM VARIATION. Bachelet, F.; Iucci, N.; Villoresi, G. (Univ., Rome. CNR, Rome). Nuovo Cim.; 7B: No. 1 45-61(11 Jan 1972).

The daily latitude curves from 1957 to 1965 obtained in Part I are used to derive the long-term spectral variation, i.e., the quasi-stationary modulation associated with the solar activity cycle. The pure solar-cycle modulation appears to be a significantly steeper rigidity function than the Forbush decrease modulation above 10 GV, with a shape fairly constant through the solar cycle. The evidence for a deviation from this constant shape, in times (1957, early 1958, and 1959) when really stationary conditions are never observed, suggests that short- and long-term variations can be more interconnected than previously anticipated. The flattening of the modulation function in the 5- to 10- GV region has to be taken into account when discussing solar-modulation mechanisms of the galactic cosmic rays. (auth)

21062 PULSAR-PRODUCED COSMIC RAYS AND THE ORIGIN OF THE LIGHT ELEMENTS. Sitte, K. (CNR, Turin. Univ., Freiburg i. B.). Nuovo Cim.; 7B: No. 1, 110-18(11 Jan 1972).

Particles accelerated in the vicinity of pulsars must traverse the expanding shell of the supernova before emerging as cosmic rays. This passage results in a considerable intensity reduction and in the production of light nuclei by fragmentation of heavy nuclei of the shell gas. It is shown that the upper limit of the pulsar contribution to the cosmic-ray flux is of the order of a few percent or less of the total galactic production, but that even then enough L nuclei are formed to make unnecessary a later "x process." Consideration of the energy spectrum suggests that most of the low-energy cosmic radiation may be due to shock acceleration, and much of the high-energy part due to pulsar acceleration. (auth)

21063 OBSERVATION OF MUONS IN EXTENSIVE AIR SHOWERS. Sakuyama, Hiroshi (Meisei Univ., Tokyo). J. Phys. Soc. Jap.; 32: No. 3, 587-95(Mar 1972).

The observation of muons in EAS relevant to the age parameter determined from a lateral density distribution of electrons was carried out by means of a neon hodoscope array at Mt. Norikura. As a result, it was found that there is a strong correlation between lateral distributions of electrons and of muons. The lateral distribution of muons as a power function of the distance r from the core axis has the exponent which varies from −0.8 to −1.7 with the change of age parameter of EAS. The empirical distribution function of muons with various age parameter can be expressed as: $\Delta\mu(r,N_e,s) = f(s)r^{-g(s)}e^{-(r/250)}(N_e/10^6)^{0.8}$ where $f(s) = 3\times10^4 \exp(-7.26s)$ and $g(s) = 8.0\exp(-2.0s)$. Another conclusion is that the cause of the existence of multicore EAS will not be due to the heavy nuclei in the primary cosmic rays but due to a high-energy interaction character. (auth)

21064 MEASUREMENT OF SULPHUR CONCENTRATIONS AND THE ISOTOPE RATIOS $^{33}S/^{32}S$, $^{34}S/^{32}S$, AND $^{36}S/^{32}S$ IN APOLLO 12 SAMPLES. Thode, H. G.; Rees, C. E. (McMaster Univ., Hamilton, Ont.). Earth Planet. Sci. Lett.; 12: No. 4, 434-8(Dec 1971).

Sulfur concentrations in five rock samples and one fines sample from the Apollo 12 mission range from 550 ppM to 903 ppm. $\delta\,^{34}S$ values for the rocks range from +0.37‰ to +0.68‰ while for the fines sample it is +8.70‰ (all with respect to Canyon Diablo troilite). The corresponding values obtained for $\delta\,^{33}S$ and $\delta\,^{36}S$ show that the isotope effects involved are mass-dependent and that the amounts of sulfur present in the samples mask spallogenic contributions to ^{33}S and ^{36}S. (auth)

21065 SEARCH FOR ^{14}C IN TEKTITES. Boeckl, Richard S. (Univ. of California, San Diego, LaJolla). J. Geophys. Res.; 77: No. 2, 367-8(10 Jan 1972).

An attempt was made to detect cosmic-ray-produced ^{14}C in australites and far-east tektites. No ^{14}C activity was found outside of statistical fluctuations. If a terrestrial age of 10^4 years is assumed for australites, a maximum cosmic-ray exposure time of 10^3 years is obtained for these tektites on the basis of a 2-σ statistical error. (auth)

21066 PRODUCTION AND PROPAGATION OF PARTICLES WITH A > 81 IN THE GALAXY. Kaiser, T. B.; Wayland, J. R.; Gloeckler, G. (Univ. of Maryland, College Park). Phys. Rev., D; 5: No. 2, 307-13(15 Jan 1972).

A detailed mathematical model is developed to describe the transformation of the charge composition of superheavy (A > 81) cosmic rays by spallation on interstellar hydrogen in the galaxy. If one takes a single source which suddenly injects particles with an r-process charge spectrum t_0 years in the past, the calculated relative abundance ratios in four atomic mass groups are consistent with measured values for $t_0 \approx 2.5\times10^5$ years. We further conclude that for any initial source distribution the upper limit on t_0 is 10^6 years. (auth)

Stars

Refer also to abstracts 21062, 21143, and 21169.

21067 (AD-718441) CHEMICAL COMPOSITION OF GASEOUS NEBULAE, HIGH-TEMPERATURE STARS, AND STARS OF UNUSUAL METAL-TO-HYDROGEN RATIOS. Final Technical Report. Aller, Lawrence H. (California Univ., Los Angeles. Dept. of Astronomy). 31 Dec 1970. 90p. (AFOSR-70-2895-TR). NTIS.

Chemical compositions of gaseous nebulae, and the atmospheres of both normal stars and objects with unusual metal/H ratio were investigated by procedures of modern spectrophotometry and stellar atmosphere theory. Particular attention was paid to the physics of gaseous nebulae as representing an example of an extended, highly attenuated, steady state, ionized plasma. The methods developed and results obtained have an impact in other areas of astrophysical interest—extended stellar envelopes, the solar corona, the filamentary structures of objects such as the solar chromosphere. (auth) (USGRDR)

21068 SOME PROPERTIES OF A COLLAPSING FLUID SPHERE. Banerjee, A. (Jadavpur Univ., Calcutta). Progr. Theor. Phys. (Kyoto); 46: No. 5, 1625-7(Nov 1971).

Faulks (1969) obtained an exact solution for a nonstatic fluid sphere in an empty background in which the distribution of matter is inhomogeneous and the pressure vanishes at the boundary. The solution is examined and various peculiarities are discussed. (W.D.M.)

21069 CONTRIBUTION TO THE HELIUM CONTENT OF THE GALAXY FROM PULSATIONALLY UNSTABLE STARS EVOLVING INHOMOGENEOUSLY. Tanaka, Yasou (Ibaraki Univ., Mito, Japan); Sakashita, Shiro. Progr. Theor. Phys. (Kyoto); 46: No. 5, 1627-8(Nov 1971).

Ledoux (1967) and Ferrari, et al. (1971) proposed the possibility of helium production by massive stars which evolved homogeneously. A similar possibility is considered in which helium is produced in massive pure hydrogen stars evolving inhomogeneously. (W.D.M.)

21070 NON-LTE MODEL ATMOSPHERES. VII. THE HYDROGEN AND HELIUM SPECTRA OF THE O STARS. Auer, L. H. (Yale Univ. Observatory, New Haven); Mihalas, Dimitri. Astrophys. J., Suppl. Ser.; 24: No. 205, 193-246(Feb 1972).

An extensive series of non-LTE calculations of the H, He I, and He II spectra of O stars was carried out by using relatively complete atomic models, allowing for several levels and lines simultaneously. Results are presented for continuum fluxes and for equivalent widths and profiles of the lines. Detailed comparisons were made with the spectra of eleven O and B0 stars. It was found that major departures from LTE play a dominant role in the formation of the H and He spectra of these stars. With the non-LTE models a consistent explanation of the observations of both lines and continua was obtained. The results show that an assumed helium/hydrogen ratio of 0.10 reproduces the observations; thus, present estimates of helium abundances in O stars are consistent with those derived by other methods. (auth)

21071 DIFFERENTIAL CONDITIONS FOR PHYSICALLY MEANINGFUL FLUID SPHERES IN GENERAL RELATIVITY. Kuchowicz, B. (Univ., Warsaw). Phys. Lett.; 38A: No. 5, 369-70(28 Feb 1972).

Such physical conditions as positive definiteness of matter density and pressure, adiabatic stability, etc., are presented in the form of inequalities relating certain functions that appear in the general formal solution; the latter solution was derived recently in isotropic coordinates for spherically symmetric matter distributions. (auth)

21072 SPECTROSCOPIC AND PHOTOMETRIC CHANGES IN THE PECULIAR INFRARED STAR VX SAGITTARIUS. Humphreys, Roberta M. (Steward Observatory, Tucson, Ariz.); Lockwood, G. W. Astrophys. J.; 172: No. 2, L59-62(1 Mar 1972).

Recent spectroscopic and photometric variations in the peculiar M supergiant-like star, VX Sgr, are reported. During the period of observation, its behavior resembled that of a Mira variable. (auth)

21073 CARBON STARS WITH COMPOSITE SPECTRA. Richer, Harvey B. (Univ. of British Columbia, Vancouver). Astrophys. J.; 172: No. 2, L63-5(1 Mar 1972).

Observations of three carbon stars exhibiting composite spectra are presented. The visual absolute magnitudes of the carbon stars in these systems are derived. The results are: TU Tau, $M_v = -3.9$; $-26°$ 2983, $M_v = -2.4$; SZ Sgr, $M_v = -1.4$. (auth)

21074 HIGH-SPEED PHOTOMETRY OF CATACLYSMIC VARIABLES. Warner, Brian; Nather, R. Edward (Univ. of Texas, Austin). Sky Telesc.; 43: No. 2, 82-5(Feb 1972).

A model is presented for nova remnants, nova-like variables, and U Geminorum stars, which can explain nearly all the spectroscopic and photometric features at normal light. (W.D.M.)

21075 SPECTROPHOTOMETRY OF THE BETA CEPHEI STARS. Watson, R. D. (Australian National Univ., Canberra). Astrophys. J., Suppl. Ser.; 24: No. 204, 167-91(Feb 1972).

Scanner observations and hydrogen line profiles are presented for the majority of the classical β Cephei stars, some recently confirmed β Cephei stars, and some of Hill's β Cephei candidates. These data, together with data from other sources and a sample of nonvarying early B stars, are used to obtain stellar temperatures and gravities via the Morton model atmospheres. The existence of a β Cephei strip in the (θ_e, log g)-plane is demonstrated and its correspondence with the S-bend region of theoretical evolutionary tracks is noted. The normality of the β Cephei phenomenon for slow rotators is emphasized. For comparison, (M_{bol}, log T_e) values derived by using the Petrie luminosity calibration are presented. A significant discrepancy exists between these data and those derived from the (θ_e, log g) approach. Masses and radii derived from the (θ_e, log g) data are given. These, combined with the periods of the classical β Cephei stars, give a mean pulsational constant $\langle Q \rangle = 0.037$. This value agrees well with the theoretically calculated Q_0 value of late-main-sequence evolutionary models. (auth)

21076 INFRARED STUDIES OF GALACTIC NEBULAE. IV. CONTINUUM AND LINE RADIATION FROM PLANETARY NEBULAE. Gillett, F. C. (Univ. of California, San Diego); Merrill, K. M.; Stein, W. A. Astrophys. J.; 172: No. 2, 367-74(1 Mar 1972).

Observations are reported of the detection of infrared radiation from several planetary nebulae not previously known to be radiating at these wavelengths. Broad spectral bandwidth observations indicate that infrared radiation in excess of that expected from atomic processes is a common phenomenon among these objects. Investigations with narrow spectral bandwidth show that in a few cases the energy in the line of S^{+3} at $\lambda = 10.52\ \mu$ is a significant fraction of the total energy observed in the broad-band measurements and in other cases a relatively small fraction of the total radiation. Other observations on two sources with narrow spectral bandwidth adjacent to the 10.52-μ line indicate that at these wavelengths a true continuum of radiation exists as well as lines. The results are discussed in relation to visual and radio-wavelength data. (auth)

21077 EFFECT OF RADIATIVE EQUILIBRIUM ON THE PHOTOSPHERIC ANGULAR VELOCITY. Durney, B. R. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 172: No. 2, 479-84(1 Mar 1972).

The photospheric angular velocity [$\omega = \omega(r)$] was evaluated in the range of optical depths $0.05 < \tau < \tau_c \sim 0.8$ under the assumption of radiative equilibrium and vanishing von Zeipel currents. The angular velocity decreases outward, and significant pole-equator temperature differences develop. The von Zeipel currents were estimated for the case of uniform rotation. (auth)

21078 SPECTRA AND ELEMENT ABUNDANCES OF COOL WHITE DWARFS. Wegner, Gary (Univ. of Washington, Seattle). Astrophys. J.; 172: No. 2, 451-78(1 Mar 1972).

An atmospheric analysis of the cool white dwarfs that show atomic metal lines in their spectra was carried out. New spectroscopic observations of five white dwarfs were obtained at Kitt Peak with the 84-inch (213 cm) telescope. Three of these stars showed sufficiently strong metal lines to carry out abundance determinations. Nongray model atmospheres computed for three of these stars are consistent with the observed M_v, π, the Chandrasekhar mass–radius relation, the G − I or V − r colors. The influence of convection was included and a temperature-correction procedure is described. Line profiles were computed by using the impact approximation with the (6, 12) Lennard–Jones potential to describe the interaction. The main result was that the atmospheres of the cool white dwarfs were found to be nearly pure He. The metal and hydrogen abundances were found to be of the order of 10^{-9} and 10^{-4} by number, respectively. (auth)

21079 POLYNOMIAL APPROXIMATION OF PARTITION FUNCTIONS FOR RARE-EARTH ELEMENTS. Aller, Margo F.; Everett, Carol H. M. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 172: No. 2, 447-50(1 Mar 1972).

Polynomial approximations are given for the computation of temperature-dependent partition functions for rare-earth elements. (auth)

21080 RATE OF THE $^{14}N(\alpha,\gamma)^{18}F$ REACTION. Couch, R. G.; Spinka, H.; Tombrello, T. A.; Weaver, T. A. (California Inst. of Tech., Pasadena). Astrophys. J.; 172: No. 2, 395-401(1 Mar 1972).

New experimental and theoretical results are presented on the $^{14}N(\alpha,\gamma)^{18}F$ reaction. A new resonance was found at $E_\alpha = 0.56$ MeV with $(2J + 1)\Gamma_\alpha \Gamma_\gamma/\Gamma = 2.8 \pm 0.5 \times 10^{-4}$ eV (lab). From a theoretical calculation of the cross section for direct radiative capture, and an extrapolation of the tails of the measured resonances to $E_\alpha = 0.0$, a value $S \approx 0.7$ MeV-barns is estimated for the nonresonant S factor. The reaction rate is calculated, and the significance of this rate is discussed. It is found that in most stars α-capture by ^{14}N takes place after the initiation of helium burning by the $3\alpha \rightarrow {}^{12}C$ reaction. (auth)

21081 VY CANIS MAJORIS. III. POLARIZATION AND STRUCTURE OF THE NEBULOSITY. Herbig, G. H. (Lick Observatory, Santa Cruz, Calif.). Astrophys. J.; 172: No. 2, 375-81(1 Mar 1972).

Direct photographs of VY CMa taken in the 6500 Å region through a Polaroid analyzer confirm 120-inch (305 cm) visual observations in showing that the small (approximately 8″ × 12″) nebula surrounding the star is radially plane-polarized in amounts up to 70%. The semistellar nuclei C, D, E, and F in the nebula that were discovered and measured by micrometric observers show the same heavy radial polarization as their nebular background, and hence must be structure in the nebulosity, not faint stars. The close component B could be neither seen nor photographed in January 1971. The time variation in amount and direction of polarization that has been observed for the integrated radiation of VY CMa plus nebula can be explained by the known variability of the brightness of the star, or of portions of the nebula. The rotation of the plane of polarization with wavelength can be explained by a wavelength variation of the relative brightness of the star and various parts of the nebula. (auth)

21082 PHOTOMETRIC STUDY OF SELECTED R CORONAE BOREALIS VARIABLES. Fernie, J. D.; Sherwood, Vicki; DuPuy, David L. (Dunlap Observatory, Richmond Hill, Ont.). Astrophys. J.; 172: No. 2, 383-90(1 Mar 1972).

UBV observations of 10 possible R CrB variables are presented. For eight of these only a few observations are available, and average values are presented. More extensive observations are available for ρ Cas and R CrB. (W.D.M.)

21083 CARBON STARS AND THE CNO BI-CYCLE. Thompson, Rodger I. (Univ. of Arizona, Tucson). Astrophys. J.; 172: No. 2, 391-3(1 Mar 1972).

It is shown that in the context of present stellar evolutionary theory, carbon stars cannot be the result of mixing CNO bi-cycle products to the surface. This is because insufficient material is processed in the stellar interior to affect the $^{12}C/^{16}O$ ratio significantly at the surface of the star. A 9 $M_\odot$ star from Iben's work is discussed as an example. Four speculative possibilities are listed for the origin of carbon stars. (auth)

21084 OSCILLATORY THERMAL INSTABILITIES AT THE ONSET OF HELIUM SHELL BURNING. Haerm, R.; Schwarzschild, M. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 172: No. 2, 403-17(1 Mar 1972).

The onset of thermal instability was investigated in detail for globular-cluster stars in the evolutionary phase during which the helium-burning shell is just forming. The investigation showed that (a) the main unstable phase ("second red-giant phase" or "asymptotic branch") is preceded by a short and inconsequential preliminary unstable phase during which the instability is weak and of an oscillatory character, (b) the main unstable phase generally commences not with a simple exponential instability (real eigenvalue), but with an oscillatory instability (complex eigenvalue), (c) this oscillatory instability appears to be caused by an interaction between the driving layer containing the helium shell source and a reacting layer below the driving layer, and (d) the oscillatory instability gives way (after a quite limited time span) to a simple exponential instability which causes the repetitive helium-shell flashes described in earlier investigations. (auth)

21085 W VIRGINIS MODEL USING RADIATION TRANSFER. Davis, Cecil G. Jr. (Los Alamos Scientific Lab., N. Mex.). Astrophys. J.; 172: No. 2, 419-21(1 Mar 1972).

Christy's model of W Vir is studied with the variable Eddington method of radiative transfer. (auth)

21086 PHYSICAL INTERPRETATION OF RECENT PERIOD–LUMINOSITY RELATIONS FOR RR LYRAE VARIABLES. Cox, J. P. (Univ. of Colorado, Boulder); Castor, J. I.; King, D. S. Astrophys. J.; 172: No. 2, 423-34(1 Mar 1972).

A simple physical interpretation is proposed of the period–luminosity (Π–L) relation for RR Lyrae variables which was found by Iben and Huchra on the basis of linearized pulsation calculations. Essentially, the intersection on the H–R diagram of the fundamental and first-harmonic blue instability edges, on which this Π–L relation is based, is caused by a "quenching" of the first harmonic. This quenching results from the proximity of the driving region, assumed here to be the region of He^+ ionization, to the node. The critical separation between this region and the node required to cause the quenching is governed primarily by the mass/radius ratio. The interpretation leads to a "theoretical" Π–L relation in good agreement with their Π–L relation. The relationship of the Iben–Huchra Π–L relation to one obtained earlier by Christy from nonlinear calculations is discussed. It is suggested that the former is, in principle, essentially a subset of the latter. The near identity of their slopes, noted by Iben and Huchra, is shown to be a consequence of the fact that the Christy Π–L relation is independent of mass. The lack of a dependence of the Christy Π–L relation on composition leads to a contradiction between Iben and Huchra's results and Christy's results if the two Π–L relations are related as suggested. The need for further nonlinear pulsation calculations is emphasized. (auth)

21087 SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEBULAE. XX. THE INHOMOGENEOUS, LOW EXCITATION, PLANETARY NGC 40. Aller, L. H. (Univ. of California, Los Angeles); Czyzak, S. J.; Buerger, E. G.; Lee, Paul. Astrophys. J.; 172: No. 2, 361-5(1 Mar 1972).

NGC 40 is characterized by extremely low excitation, an extremely irregular and inhomogeneous structure, and a bright Wolf–Rayet-type central star. Photoelectric and photographic measurements of line intensities, secured at Mount Wilson, Lick, and Kitt Peak Observatories are interpreted in terms of ionic concentrations with the aid of two suggested excitational models for the nebula. Large pockets of cool, neutral gas must exist in NGC 40. (auth)

21088 SPECTROSCOPIC BINARIES IN THE OPEN CLUSTER NGC 2516. Abt, Helmut A.; Levy, Saul G. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 172: No. 2, 355-60(1 Mar 1972).

A limited study of the radial velocities of the 16 brightest early-type stars in NGC 2516 yielded approximate periods for six binaries. Tidal interaction in that number of binaries was insufficient to explain the low mean rotational velocity obtained for the cluster stars, but allowance for the additional Ap stars, in which decreased rotation by magnetic braking may have occurred, did account for the low rotational velocities. (auth)

21089 NOVA HYDRODYNAMICS. Rose, William K.; Smith, Richard L. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 172: No. 3, 699-712(15 Mar 1972).

Calculations are described that explore hydrodynamic processes predicted to arise during the nova outburst on the basis of a model proposal by Rose. Two mechanisms for rapid mass loss are studied: (1) a direct shock-wave ejection mechanism, and (2) rapid mass loss resulting from pulsational instability. It is concluded that the direct shock-wave ejection mechanism is probably not the sole cause of mass loss in novae because it requires very high rates of nuclear energy generation and does not provide a satisfactory explanation for the velocity distributions of the ejected mass and the relatively long timescales associated with many outbursts. The dissipation of pulsationally produced shock waves appears to be a plausible means of producing considerable surface heating and an extended envelope. However, the calculations do not show how this extended envelope is ejected. Although the theory under consideration provides a satisfactory explanation for the circumstances of occurrence and maximum visual luminosity of novae, further work is needed to explain the velocity of the ejected matter. (auth)

21090 NONVARIABLE SUPERGIANTS IN THE CEPHEID INSTABILITY STRIP. Schmidt, Edward G. (Univ. of Arizona, Tucson). Astrophys. J.; 172: No. 3, 679-83(15 Mar 1972).

The temperatures of 11 supergiants of spectral types F and G were measured. The locations of these stars in the temperature–luminosity diagram were then found by using absolute magnitudes obtained from the literature. When these stars were compared with the location of the Cepheid instability strip, it was found that four of the stars lie more than 2 standard errors within the instability strip even though they are constant in light. (auth)

21091 NARROW- AND BROADBAND PHOTOMETRY OF RED STARS. VII. LUMINOSITIES AND TEMPERATURES FOR HALO-POPULATION RED STARS OF HIGH LUMINOSITY. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J.; 172: No. 3, 639-77(15 Mar 1972).

(UBVRI) observations of red giants in halo-population clusters are discussed. The clusters include 47 Tucanae, NGC 362, ω Centauri, NGC 5897, M4, M5, M92, NGC 6752, M22, and M2, as well as the old disk-population cluster M67. Some 20 variables in these clusters have also been observed, including two new variables at the tip of the giant branch in 47 Tucanae. Variable 162 in ω Centauri may not be variable, and Nos. 6, 17, and 164 in that cluster are probably field variables. The red variables, especially those with shorter periods (50 to 100 days) and small amplitudes, tend to lie above the giant branches of the clusters to which they belong. The regions of Cepheid and red-variable instability are well separated in the (M_{bol}, R–I)-plane. Four halo variables in the general field, S Car, R Pic, TY Vir, and CE Vir, are also discussed. TY Virginis is probably a member of Kapteyn's star group. With the exception of 47 Tucanae, the giant branches of these clusters roughly run from about $M_{bol} = -3.6$ mag at $(R - I)_0 = +0.63$ mag to -1 mag near $+0.28$ mag, but there are variations from cluster to cluster in the slope of this branch. In general the mean values of Δ(U – B) derived for the cluster giants correlate well with other estimates of metal abundance. The range of Δ(U – B) values is from +0.1 mag for NGC 362 to +0.7 mag for M92 and NGC 5897. An (M_{bol}, log T_e)-diagram for the variable stars and representative giant branches was obtained by using H. L. Johnson's calibration of the (R – I, log T_e)-relation. 43 references. (auth)

21092 SEARCH FOR SMALL-AMPLITUDE SPECTROSCOPIC BINARIES AMONG MAIN-SEQUENCE F-TYPE STARS. Anderson, Kurt S.; Kraft, Robert P. (Univ. of California, Santa Cruz). Astrophys. J.; 172: No. 3, 631-7(15 Mar 1972).

A search for small-amplitude spectroscopic binaries among sharp-line main-sequence stars between spectral types F3 and G1 was conducted principally with the coudé spectrograph of the Lick 120-inch reflector over a 2-year interval. Out of 45 previously supposed constant-velocity stars, seven certain and four possible stars of variable velocity were found. It is concluded that the angular-momentum density domain between 2×10^{17} and 2×10^{18} $cm^2\ s^{-1}$ remains sparsely populated with binary stars unless there exist numerous binaries of very large mass ratio (>20) and long period (>100 days). (auth)

21093 EQUILIBRIUM THERMODYNAMICS OF NONIDEAL REACTING GASES. Graboske, Harold C. Jr. (Univ. of California, Livermore). Astrophys. J.; 172: No. 3, 689-98(15 Mar 1972).

An analysis is made of the equilibrium thermodynamic properties of ionizing and dissociating gas mixtures in a system where many-body interactions are significant. The use of certain approximations, such as single-level partition functions or bound-state cutoff methods to remove divergences in the atomic partition functions, lead to thermodynamic inconsistencies. A statistical-mechanical procedure is out-lined which, for an appropriate many-body potential, includes a complete set of perturbed eigenstates, a nondivergent bound-state sum, and continuous and differentiable thermodynamic properties. Several theoretical models are applied to a solar-composition mixture to evaluate the region of validity of ideal-gas theory and the importance of various interaction effects. (auth)

21094 ABSOLUTE MAGNITUDES AND SPECTRAL TYPES OF THE STARS IN THE GAMMA VELORUM SYSTEM. Conti, Peter S. (Univ. of California, Santa Cruz); Smith, Lindsey F. Astrophys. J.; 172: No. 3, 623-30(15 Mar 1972).

The ratio of the visual luminosities of the components of the binary system, γ^2 Vel, WC8 + O, was derived by comparison of the emission-line strengths in the spectrum with those of HD 192103 (WC8). It was found that $M_V(WC8) - M_V(O) = 1.4 \pm 0.1$ mag. The classification of the O star was found to be O9 I and was without marked peculiarities. The absolute visual magnitude, −6.4, derived by Graham for the γ^2 Vel system, was confirmed by additional measures. The resulting absolute visual magnitudes of the individual components of the system were $M_V(WC8) = -4.8 \pm 0.3$, $M_V(O9\ I) = -6.2 \pm 0.2$, and $M_v(WC8) = -4.9 \pm 0.3$ in the narrow-band system of Smith. This result indicated that all WC stars have about the same absolute visual magnitude. The assumption of similarity of the emission spectrum of γ^2 Vel to that of HD 192103

and the appearance of the absorption spectrum of the O9 I star are also discussed. (auth)

21095 COLOR EXCESSES AND METALLICITIES OF THE OPEN CLUSTERS NGC 2360 AND NGC 3680. McClure, Robert D. (Yale Univ., New Haven). Astrophys. J.; 172: No. 3, 615-22(15 Mar 1972).

Intermediate-bandpass photometry on the David Dunlap Observatory (DDO) system is reported for the giant stars in the intermediate to old open clusters NGC 2360 and NGC 3680. Color excesses and cyanogen-band strengths corrected for surface gravity were determined. The metallicity inferred for both clusters is similar to solar abundance—in agreement with that determined from ultraviolet excesses of the cluster dwarfs. The discrepancy in B − V and ultraviolet excess between the NGC 3680 and M67 giants found by Eggen is removed by the higher color excess of E(B − V) = 0.09 mag determined for NGC 3680 from the DDO photometry. The high metal abundance inferred from the width of the evolved main-sequence gap is shown to be not significant because of the sparseness of the cluster. (auth)

21096 LOSS OF ANGULAR MOMENTUM DUE TO EVOLUTION OF RAPIDLY ROTATING EARLY-TYPE STARS. Gredley, Peter R.; Borra, Ermanno F. (Univ. of Western Ontario, London). Astrophys. J.; 172: No. 3, 609-14(15 Mar 1972).

Rigidly rotating stars of 5, 7, 9, and 10 $M_{\odot}$ were evolved, with loss of angular momentum under the assumption of rotational ejection of mass, from the zero-age main sequence to hydrogen exhaustion. Rates of mass loss were obtained in which the coupling between star and envelope was taken into account. The rates of mass loss obtained were more than two orders of magnitude lower than the rates determined observationally for Be and shell stars. (auth)

21097 RECOMBINATION SPECTRUM OF THE PLANETARY NEBULA NGC 7027. Miller, Joseph S.; Mathews, William G. (Univ. of California, Santa Cruz). Astrophys. J.; 172: No. 3, 593-607(15 Mar 1972).

Detailed measurement of recombination lines and continua of H^+, He^+, and He^{2+} at various positions in NGC 7027 show a remarkable agreement with theoretical prediction, contrary to earlier published results. A ratio of total to selective extinction of R = 3.47 ± 0.19 was derived. New measurements of forbidden-line intensities indicated temperatures in reasonable agreement with that appropriate for the continuum. The absence of observable optical stellar flux was consistent with recent theoretical model atmospheres of central stars of planetary nebulae. 58 references. (auth)

21098 IMAGE-TUBE PHOTOGRAPHY OF DIFFUSE NEBULAE IN [S III] λ9532. Foukal, Peter (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 172: No. 3, 591-2(15 Mar 1972).

Exposures of M17 and the central core of M8 show the potential usefulness of the [S III] λ9532 radiation in the study of emission nebulae. The line is of particular interest in studies of the obscured central region of many of the bright northern objects, since it has an optical penetration through dust about twice that of Hα, and is produced by an ion known to be abundantly present in the central regions of these diffuse nebulae. (auth)

21099 WOLF-RAYET STARS IN M33. Wray, James D. (Northwestern Univ., Evanston, Ill.); Corso, George J. Astrophys. J.; 172: No. 3, 577-82(15 Mar 1972).

Twenty-five objects in M33 were identified as Wolf−Rayet stars on the basis of narrow-band interference-filter photography. Spectra of two of the objects obtained by Lynds were interpreted as WC5 or 6 + OB. Apparent blue continuum magnitudes ranged from +17.6 to the plate limit at +19.8 yielded absolute magnitudes in reasonable agreement with the magnitudes of Wolf−Rayet stars in the Magellanic Clouds. (auth)

21100 OH OBSERVATIONS OF THE OPEN CLUSTER NGC 2264. Riegel, Kurt W.; Crutcher, Richard M. (Univ. of California, Los Angeles). Astrophys. J.; 172: No. 3, L107-10(15 Mar 1972).

The young open cluster NGC 2264 was observed as a source of 1667- and 1665-MHz OH line emission. Further observations of the cluster and several nearby points in the sky, in the main lines and in the 1612- and 1720-MHz satellite lines, showed that the OH emission is from interstellar dust clouds. The data support the interpretation of thermal OH emission from dust clouds toward and near NGC 2264, and do not support Class IIb IR-OH or other discrete sources as the origin of the 18-cm OH emission. (auth)

21101 RECENT CHANGE IN THE CIRCUMSTELLAR SPECTRUM OF U MONOCEROTIS. Preston, George W. (Hale Observatories, Pasadena, Calif.). Astrophys. J.; 172: No. 3, L105-6(15 Mar 1972).

Double circumstellar absorption components of the Ca II H- and K-lines, present in the spectrum of the RV Tauri star U Mon in 1963, are replaced by strong single absorption features with a velocity intermediate between those of the previous lines. Crude estimates of the dimensions of gas shells, hypothesized to account for the circumstellar lines, are somewhat larger than the dimensions of dust shells hypothesized to account for the infrared excesses of RV Tauri stars, including U Mon, observed by Gehrz and Woolf. (auth)

21102 DETONATION IN STELLAR CORES: THE EFFECT OF NUCLEAR STATISTICAL EQUILIBRIUM. Buchler, J.-R.; Wheeler, J. C.; Barkat, Z. (California Inst. of Tech., Pasadena). Astrophys. J.; 172: No. 3, 713-16(15 Mar 1972).

In a previous paper (Astrophys. J., 172: No. 3, 713(Mar. 15, 1972)) the local conditions (i.e., temperature, density, pressure) behind a Chapman−Jouguet detonation front and the self-consistency of the detonation were investigated for cases of astrophysical interest. The detonation was assumed to be driven by a single reaction (e.g., $2\ ^{12}C + 2\ ^{16}O \rightarrow\ ^{56}Ni$). In this paper, rather than a single product, the reaction products are assumed to be the appropriate ensemble of nuclei in nuclear statistical equilibrium. The parameters of the detonation and the condition of self-consistency are re-examined with this assumption. (auth)

21103 UNIQUE VISUAL DOUBLE STAR. Stephenson, C. B.; Sanduleak, N. (Warner and Swasey Observatory, Cleveland). Astrophys. J.; 172: No. 3, L115(15 Mar 1972).

The first known case of an apparent binary star consisting of a carbon star and an M star was discovered. (auth)

21104 SOFT X-RAY BACKGROUND AND FLARE STARS. Cavallo, G.; Horstman, H. (Laboratorio de SRE, Bologna). Nature (London) Phys. Sci.; 235: No. 58, 110(7 Feb 1972).

Various populations of stellar objects have been proposed to explain the soft x-ray background and, in particular, the component observed from the galactic plane, and it is here suggested that flare stars are not unlikely sources for the low-latitude component, and might also contribute in an essential way to the high-latitude component; unfortunately, estimates of their soft x-ray emission are uncertain. The latter factor is discussed. (UK)

21105 NONMEASURABILITY OF THE BARYON NUMBER OF A BLACK-HOLE. Teitelboim, C. (Princeton Univ., N. J.). Lett. Nuovo Cim.; 3: No. 8, 326-8(19 Feb 1972).

A neutral meson field on a Schwarzschild background interacting with a baryon source is examined. It is shown that the baryon number of a Schwarzschild black hole cannot be measured by means of strong interactions. It is conjectured that the result can be extended to a Kerr−Newman black hole. (L.B.S.)

21106 ECLIPSING VARIABLE STAR AB ANDROMEDAE. Minti, Hari; Ganea, Mihai (Astronomical Observatory, Bucharest). Stud. Cercet. Astron.; 16: No. 2, 197-205(1971). (In Rumanian).

A new estimate of the elements of the eclipsing system AB Andromedae is given. The AB And system was analyzed, using the photoelectric observations in the V filter obtained by Binnendijk in 1959. A Fourier analysis of the 99 normals between minima is represented by the expression $l_{obs} = 0.8747 + 0.0103 \cos\theta - 0.1235 \cos 2\theta$, where θ is the phase angle measured from the mid-primary eclipse. The external tangency angle θ_e was estimated, its value being between 42° and 43°. Because of the spectral-type similarity of the components, the not-too-large and positive reflection coefficient A_1 was neglected. The simultaneous solution for the primary and secondary minima, for the four unknowns: Δl_s, Δr_s, Δr_g, $\Delta(\cos^2 i)$ was obtained, using Irwin's method. (auth)

21107 CONSIDERATIONS ON THE DETERMINATION OF LONG-PERIOD APSIDAL MOTION: APPLICATION TO THE ECLIPSING BINARY SYSTEM RU MONOCEROTIS. Todoran, Ioan (Astronomical Observatory, Cluj). Stud. Cercet. Astron.; 16: No. 2, 177-89(1971).

An attempt is made to investigate the determination of long periodic apsidal motion when one cannot dispose of observed minima during a long interval of time. Also the ephemeris formulae for primary and secondary minima are considered. The method of apsidal period determination is examined for the case when the product $e \cdot \sin\omega$ is used, and the drawbacks are pointed out. In order to determine the long periodic apsidal motion, an alternative method is proposed. A practical application for RU Monocerotis is made, and the need of separate considerations of the two series of observations, before and after the jump of the orbital period, is pointed out. (auth)

21108 ASTROPHYSICAL IMPORTANCE OF THE REACTION $^{16}O(p,\alpha)^{13}N$. Woosley, S. W.; Arnett, W. D.; Clayton, D. D. (Rice Univ., Houston, Tex. Inst. of Theoretical Astronomy, Cambridge, Eng.). Phys. Lett.; 38B: No. 4, 196-8(21 Feb 1972).

The rate of the nuclear reaction $^{16}O(p,\alpha)^{13}N$ is shown to be very important in determining nucleosynthesis that occurs in the oxygen-rich layers of an exploding star. The value of the cross section for this reaction in a specified energy range will help to determine the nature of explosions that have produced the abundant elements between ^{28}Si and ^{42}Ca. (auth)

21109 PHOTOMETRIC BEHAVIOR OF CLOSE BINARY STARS. Koch, Robert H. (Univ. of Pennsylvania, Philadelphia). Publ. Astron. Soc. Pac.; 84: No. 497, 5-24(Feb 1972).

A recent catalog of eclipsing binary photometric solutions was used to assess present confidence in the eclipse analyses and their consistency with the interactions between the member stars and with the density distributions of stellar interior models. Selected systems which are not greatly evolved permit a few limiting inferences about the zero-order necessities for successful binary formation, but strenuous efforts must be made to detect observationally the earliest stages of binary formation. As a binary evolves differentially to pass through any of the assorted cases of mass exchange, photometric anomalies emerge in the light curve with a variety that is not presently understood. Selected systems are cited to illustrate the cautions necessary in interpreting these anomalies. (auth)

21110 SPECTROSCOPIC OBSERVATIONS OF STARS IN TWO STAR RINGS. Preston, George W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac.; 84: No. 497, 25-7(Feb 1972).

Spectral types of 27 stars in or near star rings 373 and 519 of Isserstedt (1968) indicate that these rings are chance configurations of field stars. (auth)

21111 UBVr PHOTOMETRY OF WHITE DWARFS AND WHITE-DWARF SUSPECTS. Schwartz, Richard D. (Univ. of Washington, Seattle). Publ. Astron. Soc. Pac.; 84: No. 497, 28-32(Feb 1972).

Photoelectric UBVr photometry is presented for 33 white-dwarf suspects from the Lowell Observatory lists. On the basis of (B − V) and (U − B) color indices, eight probable white dwarfs are identified. (auth)

21112 DIFFERENTIAL UBV PHOTOMETRY OF LY AURIGAE. Hall, Douglas S.; Heiser, A. M. (Vanderbilt Univ., Nashville). Publ. Astron. Soc. Pac.; 84: No. 497, 33-4(Feb 1972).

UBV observations (76) of the 09.5 III eclipsing binary LY Aur, obtained as part of the 1970−71 coordinated campaign, are presented. (auth)

21113 TWO NEW FAINT CARBON STARS AT HIGH GALACTIC LATITUDES. Drilling, John S. (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 84: No. 497, 35-6(Feb 1972).

Two faint carbon stars were detected during an objective-prism survey at high galactic latitudes. The spectra and colors of the two stars indicated a class of R5−R8 in both cases. The galactic coordinates and estimated distances of the two objects are l = 183°, b = −47°, r = 3.2 kpc and l = 0°, b = −43°, r = 12 kpc. (auth)

21114 PHOTOMETRY AND POLARIMETRY OF V 1057 CYGNI. Rieke, George; Lee, Thomas; Coyne, George (Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac.; 84: No. 497, 37-45(Feb 1972).

Extensive photometric and polarimetric data were obtained over a six-month interval for V 1057 Cyg. The polarization appears to be constant and of interstellar origin; the photometry, which extends nearly six octaves from the ultraviolet to λ = 22 μ in the infrared, indicates that the total observed luminosity is decreasing—having now declined ~10% from its earlier level. A model characterized by two circumstellar shells which absorb and reradiate short wavelength stellar flux from an underlying Al-type star provides the best fit to the observational data. The present variability, however, cannot be due to circumstellar activity, but appears to originate in the star itself. (auth)

21115 PASCHEN BETA EMISSION IN THE SPECTRUM OF OMICRON CETI. Kovar, R. P. (Manned Spacecraft Center, Houston, Tex.); Potter, A. E.; Kovar, N. S.; Trafton, L. Publ. Astron. Soc. Pac.; 84: No. 497, 46-50(Feb 1972).

Three infrared spectra of Omicron Ceti were obtained August 7 to 11, 1969. The equivalent width of the Paschen beta emission line in these spectra was found to vary by a factor of 2 during this time period. The variation was similar to that for Hγ and Hδ as measured by Odell et al. (1970) for the same time span. The equivalent widths of Paschen beta and Hγ on August 7 were used to estimate an opacity ratio of $\kappa(1.28\ \mu)/\kappa(0.43\ \mu) \simeq 1:30$ and a molecular/atomic hydrogen ratio of ~10. The variation in the strength of Paschen beta and Hδ lines is considered to be intrinsic and to have a time scale of $\lesssim 10^5$ seconds. (auth)

21116 RELATIVE LUMINOSITY AND SURFACE BRIGHTNESS OF THE COMPONENTS OF CONTACT BINARY STARS. Robinson, Edward L. (Univ. of Texas, Austin). Publ. Astron. Soc. Pac.; 84: No. 497, 51-5(Feb 1972).

It is shown that the model of zero-age main-sequence contact binary stars in which a common convective envelope surrounds both stars incorrectly predicts the observed ratios of luminosity and mean surface brightness of the two components of W Ursae Majoris stars. (auth)

21117 UBVβ PHOTOMETRY OF EU TAURI. Guinan, Edward F. (Villanova Univ., Pa.). Publ. Astron. Soc. Pac.; 84: No. 497, 56-60(Feb 1972).

UBV and Hβ observations of EU Tau are presented. On the basis of all the available evidence it is concluded that EU Tau is a classical cepheid with a period of 2.1052d instead of the W UMa variable as previously supposed. The photometric parameters of the star are determined. (auth)

21118 DUST MODELS FOR R CORONAE BOREALIS AND RY SAGITTARII. Krishna Swamy, K. S. (Tata Inst. of Fundamental Research, Colaba, India). Publ. Astron. Soc. Pac.; 84: No. 497, 64-7(Feb 1972).

The observed infrared emission from R CrB and RY Sgr can be explained as due to thermal emission from the shell of dust grains surrounding these stars. The emission spectrum of the dust shell was calculated as a function of the visual magnitude and also the expected flux of the star as a function of the optical depth of the dust shell. The question of the condensation of graphite particles in these stars is briefly discussed. (auth)

21119 APPEARANCE OF λ4650 EMISSION IN CYGNI X-2. Bopp, B. W.; Vanden Bout, P. A. (Univ. of Texas, Austin). Publ. Astron. Soc. Pac.; 84: No. 497, 68-9(Feb 1972).

The C III−N III λ4650 line was detected in Cyg X-2. An absorption feature is present to the blue of He II λ4686. Both lines and continuum appear to vary independently in intensity. (auth)

21120 NEW EXTENSION OF THE HELIX NEBULA. Araya, G.; Blanco, V. M.; Smith, M. G. (Cerro Tololo Inter-American Observatory, La Serena, Chile). Publ. Astron. Soc. Pac.; 84: No. 497, 70-1(Feb 1972).

A west−southwesterly extension to NGC 7293 was discovered. (auth)

21121 PULSATING METALLIC-LINE STAR. Bessell, M. S.; Eggen, O. J. (Australian National Univ., Canberra). Publ. Astron. Soc. Pac.; 84: No. 497, 72-3(Feb 1972).

HR 5491, a member of the Hyades group, was found to be both an ultrashort-period cepheid (0.08d) and a classical, metallic-line star. (auth)

21122 OBSERVATIONAL STUDIES RELATING TO STAR FORMATION. III. Aveni, Anthony F. (Colgate Univ., Hamilton, N. Y.); Hunter, James H. Astron. J.; 77: No. 1, 17-23(Feb 1972).

Data are presented and the total mass content estimated for a number of early-type clusters associated with reflection nebulosities noted by van den Bergh and Racine. Two of the clusters appear isolated from other Population I material and have total masses of ~100 $M_\odot$. They are similar in structure to the BM And complex cited by the authors in an earlier work. (auth)

21123 STRUCTURE IN THE INTERSTELLAR REDDENING LAW: 3450 TO 5800 A. Honeycutt, R. Kent (Indiana Univ., Bloomington). Astron. J.; 77: No. 1, 24-8(Feb 1972).

Photoelectric-scanner observations at 20-Å resolution of 11 reddened B supergiants (plus comparison stars) were used to study the diffuse interstellar absorption bands. In the mean extinction curve absorption features were detected at 5102, 4887, 4760, and 4430 Å. The possible existence of absorption features shortward of 4100 Å is discussed. (auth)

21124 SCANNER OBSERVATIONS OF COOL STARS FROM 3400 TO 11,000 A. Fay, T.; Honeycutt, R. K. (Indiana Univ., Bloomington). Astron. J.; 77: No. 1, 29-34(Feb 1972).

Photoelectric scans of the M supergiant α Ori and the carbon stars 19 Psc, W Ori, and DS Peg were made at 20-Å resolution

from 3400 to 6000 Å and at 40-Å resolution from 6000 to 11,000 Å. The data are corrected for atmospheric extinction and for the instrumental response to obtain plots of log flux per unit frequency interval versus wavelength. The dominant spectral features are due to C_2, CN, and TiO; the variation of these features with spectral class is pointed out. (auth)

21125 SPECTRAL CLASSIFICATION OF THE F STARS OF INTERMEDIATE LUMINOSITY. Morgan, W. W. (Yerkes Observatory, Williams Bay, Wis.); Abt, H. A. Astron. J.; 77: No. 1, 35-7(Feb 1972).

A general procedure in visual spectral classification is outlined which makes use of all significant spectral features in the available wavelength region. A grid of standard F-type stars of luminosity classes II–IV is given. This grid is on the MK system, but it defines a localized structure of higher internal precision than the latter. The revised (Morgan, Keenan, Abt) system is used for the determination of new types for 14 stars of the δ Scuti class. All are found to have luminosity classes above the main sequence, and a range in spectral peculiarities is found within the group. (auth)

21126 SEVEN NEW SPECTROSCOPIC BINARIES IN CEPHEUS. Garmany, Catharine D. (Leander McCormick Observatory, Charlottesville, Va.). Astron. J.; 77: No. 1, 38-41(Feb 1972).

Orbital elements are presented for seven new spectroscopic binaries in the association Cep OB 3. Their periods range from 1 to 100 days, and their semi-amplitudes range from 20 to 65 km/sec. (auth)

21127 OCCULTATION OF BETA SCORPII BY JUPITER AND Io. I. JUPITER. Hubbard, W. B.; Nather, R. E.; Evans, David S.; (and others) (Univ. of Texas, Austin). Astron. J.; 77: No. 1, 41-59(Feb 1972).

Three one-dimensional area-scanning photometers under computer control, equipped to observe in one color, were taken to observing stations in Australia, India, and Africa to observe the occultation of the Beta Scorpii system by Jupiter on May 13, 1971. Six high-quality light curves were obtained; three of the occultations of the brighter component Beta Sco A and three of Beta Sco C. The mean scale height of the Jovian upper atmosphere is 32 ± 6 km near $-10°$ zenographic latitude, 31 ± 2 km at $-47°$ zenographic latitude, and 24 ± 2 km at $-57°$ zenographic latitude. The determination of the atmospheric scale height is highly sensitive to the background level subtracted, providing a possible explanation of an earlier result by Baum and Code placing the scale height at about 8 km. Correlated departures of the light curve from a theoretical isothermal curve are reproduced in the three bright-star curves, and are thus not due to random density fluctuations in the Jovian atmosphere, but rather due to global stratification. Details of the stratification, which includes at least a number of warm layers, are examined by deconvolution of the light curves. There is evidence for a high temperature ($T > 300$ K) thermosphere on two of the bright-star light curves. (auth)

21128 OCCULTATION OF BETA SCORPII BY JUPITER AND Io. II. Io. Bartholdi, Paul; Owen, Frazer (Univ. of Texas, Austin). Astron. J.; 77: No. 1, 60-5(Feb 1972).

Photoelectric observations of the occultation of β Sco C (β^2 Sco) by the Jovian satellite Io were made on May 14, 1971 from St. Thomas in the Virgin Islands. Accurate times of ingress and egress were determined, and the effects of Fresnel diffraction at the limb of Io were observed. In spite of the extreme sensitivity of such an observation to refraction, no effects due to the presence of an atmosphere were detected. This places an upper limit of $P \leq 7 \times 10^{-9}\ (T/\mu)^{\frac{1}{2}}$ for any atmosphere on Io. In carrying out this analysis it was necessary to take account of the angular diameter of β Sco C which may be estimated from astrophysical arguments at about 2.0×10^{-4} arc sec while the best observational fit corresponds to 1.6×10^{-4} arc sec. The detailed structure of the trace strongly suggests the presence of a faint companion to β Sco C. (auth)

21129 OCCULTATION OF BETA SCORPII BY JUPITER AND Io. III. ASTROMETRY. Hubbard, W. B. (Univ. of Texas, Austin); Van Flandern, T. C. Astron. J.; 77: No. 1, 65-74(Feb 1972).

The timings of the occultation events of May 13-14, 1971 are used to derive a value for the equatorial radius and oblateness of Jupiter at an atmospheric level corresponding to a refractivity of 10^{-9}. Two independent analyses are presented; discrepancies between the results give a measure of the sensitivity to initial assumptions. Analysis of the Io occultation data gives an additional determination of the declination of the center of Jupiter and permits a more precise determination of the Jovian oblateness than would have otherwise been possible. For Io, a radius of 1829 ± 3 km; for Jupiter, the equatorial radius is $71,880 \pm 30$ km, and the oblateness $(R_{eq} - R_{pol})/R_{eq} = 0.060 \pm 0.001$ (mean of the two analyses) were obtained. The apparent semidiameters of Jupiter at unit distance for the 50% transmission level in the atmosphere are 99.00″ equatorial and 93.10″ polar. The derived oblateness is in good agreement with other determinations of the optical oblateness, and the discrepancy with the dynamical oblateness is confirmed. Possible sources of systematic error are discussed. (auth)

21130 PROPER MOTIONS, MEMBERSHIP, AND STELLAR CONTENT OF THE OLD CLUSTER NGC 188. Upgren, A. R.; Mesrobian, W. S.; Kerridge, S. J. (Wesleyan Univ., Middletown, Conn.). Astons. J.; 77: No. 1, 74-84(Feb 1972).

Proper motions and probabilities of membership were determined for 228 stars in the field of NGC 188 from plates covering a 40-yr interval taken with the 30-inch Thaw Refractor of the Allegheny Observatory. The survey was complete to a limiting blue magnitude of 15.6. An eight-parameter solution was made in which the motions are represented by a bivariate frequency function with circular and elliptical models for the motions of the cluster members and the field stars, respectively. A 67-star reference frame provides a stable solution in which a clear distinction between members and field stars is made. The majority of recognized super-metal-rich stars and blue stragglers are highly probable members. The field-star counts agree with previous estimates but the member-star counts tentatively suggest a downward revision in the total mass of the cluster. The proper motions, combined with radial-velocity data, lead to a circular galactic orbit and a period of oscillation through the plane of 146×10^6 yr. The velocity at the plane and perpendicular to it is about 43 km/sec indicating an old-disk membership. Motions for a greater proportion of the total stellar population of the cluster are necessary in order to determine its gravitational stability. (auth)

21131 PARALLAX AND ASTROMETRIC ORBIT OF THE SPECTROSCOPIC BINARY γ GEMINORUM FROM OBSERVATIONS WITH THE 20-INCH REFRACTOR OF THE VAN VLECK OBSERVATORY. Kamper, Karl W. Jr. (Wesleyan Univ., Middletown, Conn.). Astron. J.; 77: No. 1, 85-7(Feb 1972).

Measurements of 130 parallax plates of γ Geminorum covering the time interval 1932–1958 confirmed the 12½-yr orbital period previously announced by Wagman, Daniel, and Crissman (1963). The parallax and photocentric semimajor axis were found to be $+0.031 \pm 0.003''$ (m.e.) and $0.065 \pm 0.016''$ (m.e.) from the Van Vleck material. The pair should be near maximum separation, about 0.3″, for the next two years. (auth)

21132 EVIDENCE OF MASS LOSS FROM A CLOSE BINARY SYSTEM: THE HYADES MEMBER ECLIPSING BINARY BD + 16°516. Vauclair, G. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys.; 17: No. 3, 437-40(Mar 1972).

It is shown that the Hyades member eclipsing binary BD + 16° 516 must be the product of late evolution of an initial system composed of a $\sim 1.9\ M_\odot$ primary and a $\sim 0.4\ M_\odot$ secondary. The present evolved system being composed of a $\sim 0.8\ M_\odot$ KOV star on the main sequence and of a $\sim 0.7\ M_\odot$ hot white dwarf, it is argued that the evolution of such a system took place through both a mass exchange of $\sim 0.4\ M_\odot$ from the primary to the secondary and a mass loss of $\sim 0.8\ M_\odot$, probably through a planetary-nebula phase. (auth)

21133 UBVr COLOBS OF SUPERGIANTS. Boehm-Vitense, E. (Univ. of Washington, Seattle). Astron. Astrophys.; 17: No. 3, 335-53(Mar 1972).

The atmospheres of supergiants were studied in the range $4000 \leq T_{eff} \leq 9000°$. The influence of radiation pressure and spherical effects are discussed. The observed colors of supergiants were obtained with radiative equilibrium and hydrostatic models. A calibration of B – V in terms of T_{eff} is given. The T_{eff} obtained for G and K supergiants were about 10% lower than adopted so far. (auth)

21134 ABUNDANCE ANALYSIS OF THE LATE TYPE SUPERGIANT, EPSILON PEGASI. Warren, P. R.; Peat, D. W. (Univ. Observatories, Cambridge, Eng.). Astron. Astrophys.; 17: No. 3, 450-7(Mar 1972).

Spectrograms of dispersion 1.5 Å/mm in the wavelength region 5600 to 6300 Å were used to derive the effective temperature, surface gravity, and metal abundances of the K-type supergiant, epsilon Pegasi. The spectra were analyzed with a differential curve of growth and spectrum synthesis method, based on LTE

model atmospheres. Values of $T_e = 4180 \pm 50$°K and log g = 1.0 ± 0.3 were obtained, leading to a mass of approximately 10 solar masses. Relative to the solar abundances, magnesium was found to be deficient by a factor of approximately 7, silicon and titanium deficient by a factor of 2, iron peak elements deficient by a factor of approximately 1.5, barium overabundant by a factor of 10, and heavy elements possibly overabundant by a factor of approximately 2. The suggestion is made that the abundances of the light elements ($A \lesssim 62$) in ϵ Peg could have resulted from explosive carbon burning in the progenitor material occurring at a lower temperature than that in the solar progenitor material. (auth)

21135 FLUORESCENT Fe I EMISSION IN LONG-PERIOD VARIABLES. Willson, L. A. (Univ. of Michigan, Ann Arbor). Astron. Astrophys.; 17: No. 3, 354-61(Mar 1972).

A statistical-equilibrium analysis of the fluorescent emission of λλ 4202, 4308 of Fe I in long-period variables indicates that the coincidence mechanism first proposed by Thackeray (1937) is consistent with the observed intensities. In addition, the analysis gives some indications of conditions present in the atmospheres of long-period variables during the post-maximum phase. (auth)

21136 BINARY SYSTEM AU PUPPIS. Bossen, H. (Hamburg Observatory). Astron. Astrophys.; 17: No. 3, 362-6(Mar 1972).

The eclipsing binary AU Puppis was observed photoelectrically by Chambliss (1968). His attempts to find orbital elements of this system failed, due to difficulties in the process of rectification. A reexamination of Chambliss' data by applying perturbations and differential corrections gave consistent elements. Absolute elements were calculated and they show that the system consists of a A0V star of 3.0 solar masses and of a A1.5V star of 2.1 solar masses. The system belongs to the detached ones and the components do not differ much from spherical shape. (auth)

21137 PULSATION OF MODELS IN THE LOWER PART OF THE CEPHEID INSTABILITY STRIP AND PROPERTIES OF AI VELORUM AND δ SCUTI VARIABLES. Petersen, J. Otzen; Joergensen, H. E. (Univ. of Copenhagen). Astron. Astrophys.; 17: No. 3, 367-77(Mar 1972).

In the lower part of the cepheid instability strip two types of variable stars are recognized: δ Scuti stars and AI Velorum variables. Pulsation properties of models in the lower cepheid instability strip were analyzed and the results were compared with available observational data for the variables. Six chemical compositions were considered ranging from extreme Pop II (Z = 0.001) to Pop I (Z = 0.03) and models were constructed with masses from 0.5 to 1.6 $M_\odot$. Comparing theoretically derived period ratios with observational data for AI Vel variables, it is shown that this group of stars can not belong to Pop I. For 53 δ Sct stars UVBYβ photometry was used to derive effective temperatures, luminosities, gravities, and masses, assuming these stars to be Pop I stars evolving in the main-sequence or the immediate post-main-sequence hydrogen-burning stages. For those with known periods the Q value corresponding to the excited oscillation was derived. However, due to uncertain periods and insufficient photometry, only a small fraction of the Q values can be considered reliable. It is concluded that both the fundamental mode and at least the first three overtones may occur among the δ Scuti variables. (auth)

21138 CHARACTERISTICS OF OH EMISSION FROM INFRARED STARS. Wilson, W. J. (Aerospace Corp., El Segundo Calif.); Barrett, A. H. Astron. Astrophys.; 17: No. 3, 385-402(Mar 1972).

The characteristics of OH emission sources associated with late M-type variable stars are discussed. A total of 456 IR stars and 18 other objects were surveyed and OH emission was detected from 25 IR stars. Including four OH sources discovered by other observers, there are 29 OH emission sources associated with IR stars. In addition there are 8 OH sources which have OH emission characteristics similar to the OH/IR stars but for which no IR star has yet been detected. Based on their OH, IR, and visual properties, the OH/IR stars can be divided into three groups. The group of OH/IR stars (19 stars) with their OH emission strongest at 1612 MHz and concentrated in two narrow velocity ranges is discussed. These OH sources are associated with late M-type long-period Mira variables which have excess radiation from 5 to 10 μ, indicating perhaps a circumstellar dust shell. It is proposed that the OH maser is pumped by the IR radiation and that the OH clouds are expanding asymmetrically outward from the star. (auth)

21139 OB STAR DISTRIBUTION IN PUPPIS. Havlen, R. J. (European Southern Observatory, Santiago de Chile). Astron. Astrophys.; 17: No. 3, 413-24(Mar 1972).

UBV and H β photometry were completed for all of the OB stars of the Tontanzintla surveys between l^{II} = 240 and 250° in Puppis. The existence of the two associations Pup OB1 and Pup OB2 is confirmed. Pup OB1 is located at a mean distance of 2.5 kpc with an estimated age of 4×10^6 years. The cepheid AQ Pup is a likely candidate for membership in Pup OB1. Pup OB2 has a mean distance of 4.2 kpc with an estimated age of 2×10^6 years. The galactic cluster NGC 2467 is found to have some members in common with Pup OB2 and is probably more distant than previously indicated. In general the OB star distribution correlates well with the H I distribution found by Hindman and Kerr at l^{II} = 245°. The OB associations fall near maxima in the hydrogen distribution. (auth)

21140 ZATMENNYE PEREMENNYE ZVEZDY. (Eclipse of Variable Stars). Tsesevich, V. P. (ed.). Nestatsionarnye Zvezdy i Metody ikh Issledovaniya. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1971). 352p.

Various forms of photometric phases of eclipses are discussed in this treatise before proceeding to eclipse types: spherical stars moving in circular orbits, systems containing deformed components, and elliptical orbits. Limb darkening on the disk of a star and the use of electronic computers in connection with eclipse observations are included. (K.S.W.)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 21138.

21141 (AD-487207) WAVELENGTH DEPENDENCE OF INTENSITY VARIATIONS IN QUASI-STELLAR RADIO SOURCES. Moffet, Alan T. (Owens Valley Radio Observatory, Pasadena, Calif.). 1966. Contract Nonr-220(19). 11p. NTIS.

Variations in the intensities of three quasi-stellar radio sources at 3.75-cm wavelength have been reported by Dent. It is important to confirm the presence of these variations and to establish the way they depend on observing wavelength; a knowledge of the wavelength dependence of the variations is an essential prerequisite to their theoretical interpretation. Observations made with the interferometer at the Owens Valley Radio Observatory confirmed the intensity variations in all three sources reported by Dent. They also indicated that the variations cut off at long wavelengths, which is the behavior expected from theoretical considerations. (auth) (USGRDR)

21142 (AD-732225) M17 AND TAURUS A: 3.4-MM CONTOUR MAPS AND INTEGRATED FLUXES. Report for January 1966-March 1971. Montgomery, John W.; Epstein, Eugene E.; Oliver, John P.; Dworetsky, Michael W.; Fogarty, William G. (Aerospace Corp., El Segundo, Calif. Florida Univ., Gainesville). 1 Oct 1971. Contract F04701-71-C-0172. 24p. (SAMSO-TR-71-223). NTIS.

Contour maps at 3.4-mm of M17 (the Omega Nebula) and Tau A (the Crab Nebula) yield total integrated fluxes of 300(+50, −40) and 215(+44, −34) $\times 10^{-26}$ W/m^2-Hz, respectively. These results are in agreement with the values predicted by extrapolating data obtained at longer wavelengths. The M17 result is consistent with a thermal origin for the radiation. The low signal-to-noise ratio results reported by others, which indicated anomalously high total fluxes for Tau A at millimeter wavelengths, are not confirmed. The 3.4-mm maps are consistent with maps made at longer wavelengths. (auth) (USGRDR)

21143 (FRNC-TH-138) JEANS CRITERIA AND THE FORMATION OF STARS IN THE SUPER HEAVY MATTER-ANTIMATTER STAR MODEL OF OMNES. Montmerle, Thierry (Paris Univ. (France)). 1971. 168p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The Jeans criterion is used to study the formation of stars within the nucleus of a quasar. The Omnes model (a model consisting of a superheavy star with an antimatter nucleus enveloped with ordinary matter) is used. The opacity of the medium to the thermal photons and the γ photons produced in antimatter−matter annihilation is studied. It is shown that Thomson scattering is the dominant cause of the opacity to the thermal photons. γ photons are absorbed either by the Compton effect (energy < 1 MeV), or by electron pair production (energy < 50 MeV). The coefficients of opacity are calculated. The γ-photon transfer in the nucleus is studied, and the propagation velocity for a perturbation in the nucleus is calculated. The Jeans criterion is estab-

lished for the conditions encountered in the medium. The Jeans length is greater by an order of magnitude that the dimensions of the nucleus, indicating that stars cannot form. (France)

21144 SOFT X RAYS FROM THE VICINITY OF THE NORTH POLAR SPUR. Bunner, A. N.; Coleman, P. L.; Kraushaar, W. L.; McCammon, D. (Univ. of Wisconsin, Madison). Astrophys. J.; 172: No. 2, L67-72(1 Mar 1972).

Soft x rays in the region E < 284 eV and 500 < E < 1000 eV were detected from the vicinity of the North Polar Spur. (auth)

21145 UPPER LIMITS TO THE SOFT X-RAY EMISSION OF SOURCES IN VIRGO. Gorenstein, P.; Harris, B.; Gursky, H. (American Science and Engineering, Cambridge, Mass.). Astrophys. J.; 172: No. 2, L41-5(1 Mar 1972).

Soft x rays from Virgo were observed with a scanning focusing collector from an Aerobee 170 rocket. The region included the center of the Virgo cluster of galaxies, a source at higher energies which had been previously identified with M87, and QSO 3C 273. The instrument was sensitive in the energy bands 0.15 to 0.28 and 0.5 to 1.2 keV. No discrete sources in Virgo were observed. The upper limit on the energy flux from sources ≤0.5 is 6.6×10^{-11} ergs cm^{-2} s^{-1} (0.15 to 0.28 keV) and 5.3×10^{-10} ergs cm^{-2} s^{-1} (0.5 to 1.2 keV). The situation is more complex in the case of possible extended sources. At the location of M87 an angular extent of 1° would raise the upper limits by a factor of $\sqrt{2}$. Even if attenuation in our own Galaxy by 2.5×10^{20} H atoms cm^{-2} of interstellar matter is taken into account, the results lie below extrapolations of power-law spectra with a constant spectral index which fit the higher-energy results on "M87." Extrapolations of thermal spectra fitted to higher-energy data are consistent with the results. (auth)

21146 LOW-ENERGY GAMMA-RAY SPECTRUM OF SCORPIUS X-1. Haymes, R. C. (Rice Univ., Houston, Tex.); Harnden, F. R. Jr.; Johnson III, W. N.; Prichard, H. M.; Bosch, H. E. Astrophys. J.; 172: No. 2, L47-9(1 Mar 1972).

A 2-hour balloon altitude observation of Sco X-1, in the 16- to 930-keV energy band, was conducted from Argentina on November 25, 1970. The 16- to 41-keV data are consistent with an extension of the low-energy exponential spectrum. In addition, a penetrating component was detected at higher energies. The energy–flux power law $0.4E^{-(0.8\pm0.3)}$ and the expression 0.02 exp [– E/190(+180, –90)] keV cm^{-2} s^{-1} keV^{-1} are equally acceptable approximations to this latter component in the 35 to 300-keV energy interval. The spectrum is lost in the background at energies greater than 300 keV, where upper limits are established. (auth)

21147 STABILITY OF THE CRAB PULSAR. Horowitz, P. (Harvard Univ., Cambridge, Mass.); Papaliolios, C.; Carleton, N. P. Astrophys. J.; 172: No. 2, L51-4(1 Mar 1972).

Optical pulses from the Crab pulsar show none of the amplitude or pulse-shape variations associated with the radiofrequency pulsar. Observations designed to detect polar precession were also negative. (auth)

21148 INFRARED OBJECTS IN H II REGIONS. Allen, David A. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 172: No. 2, L55-8(1 Mar 1972).

The discovery of 2-μ sources in NGC 2264, IC 2087, and M1-82, and of prominent infrared emission in Lk Hα 198 and V376 Cas is reported. (auth)

21149 BRAKING INDEX AND PERIOD–PULSE-WIDTH DISTRIBUTION OF PULSARS. Roberts, D. H.; Sturrock, P. A. (Stanford Univ., Calif.). Astrophys. J.; 172: No. 2, 435-41 (1 Mar 1972).

The braking index n and the period–pulse-width distribution of pulsars were reinvestigated by relaxing the conventional assumption that $R_Y = R_L$, where R_Y is the radius of the neutral points marking the transition from closed to open field lines, and R_L is the radius of the "light cylinder." This assumption was replaced by the relation $R_Y = R^{1-\eta}R_L^{\eta}$, where R is the radius of the neutron star. It was found that a good fit to the period–pulse-width distribution could be obtained for η in the range $0.5 \leq \eta \leq 0.7$. The relation $n = 1 + 2\eta$ then gave $n = 2.2 \pm 0.2$, which was in good agreement with values measured for the Crab pulsar. This model implied that one or two pulsars should show an interpulse, in agreement with observation (two). This model leads to new estimates of the surface magnetic field strength B of pulsars, giving $B = 10^{11.2}$ gauss for the Crab pulsar, and indicates that pulsar magnetospheres are subject to irregular changes associated with irregularities in period. (auth)

21150 OPTICAL POLARIZATION OF SCORPIUS X-1. Landstreet, J. D. (Columbia Univ., New York. Univ. of Western Ontario, London); Angel, J. R. P. Astrophys. J.; 172: No. 2, 443-6(1 Mar 1972).

Observations of the wavelength and time dependence of the optical polarization of Sco X-1 show that the effect is consistent with an interstellar origin. (auth)

21151 SURVEY OF MOLECULAR LINES NEAR THE GALACTIC CENTER. I. 6-CENTIMETER FORMALDEHYDE ABSORPTION IN SAGITTARIUS A, SAGITTARIUS B2, AND THE GALACTIC PLANE FROM $l^{II} = 359.4°$ TO $l^{II} = 2.2°$. Scoville, N. Z. (Columbia Univ., New York); Solomon, P. M.; Thaddeus, P. Astrophys. J.; 172: No. 2, 335-53(1 Mar 1972).

The $1_{11} \rightarrow 1_{10}$, 4830-MHz transition of formaldehyde was mapped in Sgr A, Sgr B2, and along the galactic equator from $l^{II} = 359.4°$ to $l^{II} = 2.2°$ with a 6′ beam and velocity resolution of 1 km s^{-1}. That this line was observed in absorption in all locations indicated a low 6-cm excitation temperature for all molecular clouds. Comparison with 21-cm data indicated that the H_2CO is concentrated in distinct clouds to a much greater extent than atomic hydrogen, with many strong H_2CO features occurring at velocities with weak or missing hydrogen lines. This suggested that most of the mass in these clouds is in the form of molecular hydrogen. There are four dominant clouds occurring at $l^{II} = 0.0$, 0.7, 0.9, and 1.7°. In contrast with atomic hydrogen, the strongest formaldehyde features occur at $|V_{LSR}| > 40$ km s^{-1} and are apparently associated with the galactic nucleus. Estimates of the hydrogen density in these clouds, based on the assumption of stability and also on a comparison with local dark clouds, indicated a number density in the range of 10^3 to 10^4 cm^{-3}, and a mass of approximately 5×10^5 $M_\odot$. (auth)

21152 PREDICTIONS ON FINDING THE NH AND NH_2 RADICALS IN INTERSTELLAR SPACE. Kerns, B.; Duncan, A. B. F. (Univ. of Virginia, Charlottesville). Astrophys. J.; 172: No. 2, 331-4(1 Mar 1972).

Frequencies were calculated for transitions in the NH and NH_2 radicals, which are expected to occur in the microwave region usually covered by radioastronomy. NH should be observed in low-temperature sources, while NH_2 may be observed in sources whose state temperatures are greater than about 80°K. (auth)

21153 CYCLO-SYNCHROTRON RADIATION AT SMALL ANGLES. Tademaru, E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 172: No. 2, 327-30(1 Mar 1972).

Cyclo-synchrotron emission at small angles θ to the magnetic field has a spectral form in frequency quite different from the usual synchrotron spectrum. In particular, the frequency spectrum at $\theta = 0$ has a spectral index equal to the energy index of the radiating particles for frequencies above $2\omega_B\gamma_{min}$, where $\omega_B = eB/mc$ is the gyrofrequency and $\gamma_{min}mc^2$ is the minimum energy of the particles. Particles confined to a narrow range of very small pitch angles have a similar spectral index. Thus care must be taken in interpreting the spectral index of sources with special geometries. (auth)

21154 HIGH-RESOLUTION OBSERVATIONS OF COMPACT RADIO SOURCES AT 13 CENTIMETERS. II. Broderick, J. J. (National Radio Astronomy Observatory, Green Bank, W. Va.); Kellermann, K. I.; Shaffer, D. B.; Jauncey, D. L. Astrophys. J.; 172: No. 2, 299-305(1 Mar 1972).

Observations made at 13 cm with a tracking interferometer 25×10^6 wavelengths long were used to investigate the structure of the compact radio sources. The data show complex structure, so that, in general, it is not possible to discuss specific models with the limited data from this single baseline. It is established, however, that the compact components are confined to a region ≲1″ arc. (auth)

21155 LIMITATIONS ON THERMAL AND NONTHERMAL MODELS FOR THE RADIATION FROM EXTRAGALACTIC SOURCES. Jones, T. W.; Kellogg, P. J. (Univ. of Minnesota, Minneapolis). Astrophys. J.; 172: No. 2, 283-98(1 Mar 1972).

Both thermal and nonthermal models for the radiation from QSOs and Seyfert galaxies are discussed in terms of the size limitations imposed by the models. It is concluded that if daily fluctuations in the luminosity of Seyfert galaxies are confirmed and do represent a maximum size for the sources, then neither dust models nor ordinary synchrotron models can explain the radiation. Colgate's proposal involving the production of infrared radiation by a nonthermal plasma is considered, and a more detailed theory is derived which indicates that the process cannot produce infrared radiation. (auth)

21156 EVIDENCE FOR HARD X-RAY PULSATIONS FROM THE VELA PULSAR. Harnden, F. R. Jr.; Johnson III, W. N.; Haymes, R. C. (Rice Univ., Houston, Tex.). Astrophys. J.; 172: No. 3, L91-4(15 Mar 1972).

A source of hard x radiation has been detected in the general direction of the Vela X supernova remnant. The data obtained during a 1970 balloon flight also show evidence of periodic hard x-ray pulsations with a frequency near that of the radio pulsar PSR 0833-45. (auth)

21157 INTERFEROMETER POSITIONS OF EIGHTEEN OH EMISSION SOURCES. Hardebeck, Ellen G. (California Inst. of Tech., Pasadena). Astrophys. J.; 172: No. 3, 583-9(15 Mar 1972).

The two-element interferometer of the Owens Valley Radio Observatory was used to measure the positions of 13 sources in the 1612-MHz line of OH. Five sources are associated with infrared emitters (IRC + 10011, IRC + 50137, Orion A, VX Sgr, and R Aql). The OH positions agree with the infrared or optical positions to within the errors of measurement (from ±5 to ±20 arc seconds). Eight other sources that have similar OH spectra but have no detected infrared radiation were also measured. These new positions will make a search for the associated infrared objects more practical. In addition, positions were found for five main-line sources of interest. The OH source near NGC 2438 was found not to coincide with the planetary nebula. The new position for W75(N) lies near a weak continuum source. (auth)

21158 NEW COMPLETE SAMPLE OF QUASI-STELLAR RADIO SOURCES AND THE DETERMINATION OF THE LUMINOSITY FUNCTION. Lynds, Roger (Kitt Peak National Observatory, Tucson, Ariz.); Wills, D. Astrophys. J.; 172: No. 3, 531-52(15 Mar 1972).

New spectroscopic and photometric observations are reported for 19 quasi-stellar objects identified with 4C radio sources in a selected region of the sky. These objects, together with 12 previously studied 4C quasi-stellar radio sources in the same area of sky, form a sample that is complete in radio and optical properties. The combined data for this sample are used to examine the spatial distribution of the objects and to derive their bivariate radio and optical luminosity function at a distance corresponding to a redshift $z = 1.0$. The results are compared with those of a similar study by Schmidt of a complete sample of 3 CR quasi-stellar sources. (auth)

21159 LOW-MASS PROTOGALAXIES AND ABSORPTION LINES IN QUASI-STELLAR OBJECTS. Arons, Jonathan (Princeton Univ., N. J.). Astrophys. J.; 172: No. 3, 553-62(15 Mar 1972).

The possibility is explored that the many weak unidentified absorption lines in high-redshift QSO spectra are Lα lines of hydrogen. The likely existence of a metagalactic flux of ionizing radiation indicates that hydrogen clouds at high redshifts must be thoroughly ionized. Observations of PHL 957 show that the suggested clouds may be low-mass ($M < 10^{10.1}\ M_\odot$) protogalaxies. A simple model for the clouds' collapse and for the flux of ionizing radiation is used to compute the distribution of expected Lα lines in the spectrum of a QSO as a function of wavelength and H I column density. The computed distribution is in accord with observations of the two most distant QSOs, PHL 957 and 4C 05.34. Crudities in the theory and stronger tests of its validity are also discussed. 38 references. (auth)

21160 EVIDENCE FOR THE BINARY NATURE OF CENTAURUS X-3 FROM UHURU X-RAY OBSERVATIONS. Schreier, E.; Levinson, R.; Gursky, H.; (and others) (American Science and Engineering, Inc., Cambridge, Mass.). Astrophys. J.; 172: No. 3, L79-89(15 Mar 1972).

Analysis of data spanning a year of observations of the pulsating x-ray source Cen X-3 from Uhuru has revealed the existence of periodic variations in intensity of the source and correlated sinusoidal variations in the period of the 4.8s pulsations. This effect is interpreted as due to an occulting binary system. The changes in intensity are then due to occultation of the x-ray source by a large massive companion, and the sinusoidal variations in the period of the 4.8s pulsations are due to Doppler effect. The orbital period of the x-ray source is 2.08712 ± 0.00004d. The time of occurrence of the center of occultation is JD(2,441,132.081 ± 0.001) ± n(2.08712 ± 0.00004). Physical parameters for the system are derived. Evidence for the existence and nature of an extended atmosphere surrounding the massive occulting object is discussed. (auth)

21161 DISSIPATIVE PROCESSES IN NEUTRON-STAR CRUSTS AND THE PRODUCTION OF BLACKBODY X-RAY SOURCES. Henriksen, R. N.; Feldman, P. A.; Chau, W. Y. (Queen's Univ., Kingston, Ont.). Astrophys. J.; 172: No. 3, 717-28(15 Mar 1972).

It is shown how a significant fraction of the rotational energy of a neutron star may be converted into heat in the crystalline mantle by the action of a steady wobble. It is further shown that this process can produce kilovolt surface temperatures and so may imply the existence of blackbody x-ray sources in the soft x-ray band. In the latter part, the actual physical processes involved are considered—dissipation by strain hysteresis in the crust and/or dissipation at the boundary layer between the core and the mantle—and it is demonstrated explicitly that effective blackbody surface temperatures in the kilovolt range can indeed be obtained. The importance of plastic flow for large wobble amplitudes, which could lead to small spin changes and temporarily increased heating of the crust, is discussed. Application is made to the unusual x-ray source Cen XR-3, and attention is also drawn to the Crab pulsar as a potentially detectable source of this type. (auth)

21162 COMMENTS ON THE VIBRATIONS OF A BLACK HOLE. Goebel, C. J. (Univ. of Wisconsin, Madison). Astrophys. J.; 172: No. 3, L95-6(15 Mar 1972).

It is shown that the "vibrations of a black hole" of Press are gravitational waves in spiral orbits close to the well-known unstable circular orbit at $r = 3M$. The corresponding "vibrations" of a spinning black hole are discussed. It is emphasized that these "vibrations" provide, not a source, but only a temporary storage, of high-frequency gravitational radiation. (auth)

21163 NEUTRON STAR MAGNETISM. Heintzmann, H. (Univ., Cologne); Grewing, M. Z. Phys.; 250: No. 3, 254-62 (1972).

It is shown that an appreciable change of magnetic moment of a neutron star cannot occur via ohmic dissipation, and pulsars provide evidence for large internal magnetic fields in main-sequence stars. If pulsars are born from stars with masses exceeding $3M_\odot$, the internal field must be of the order of 10^3 to 10^4 G, while if they derive from less-massive stars, a field of 10^2 G is sufficient to give rise to a magnetic moment of $M \sim 10^{30}$ G cm^3. (auth)

21164 COUNTS OF INTENSE EXTRAGALACTIC RADIO SOURCES AT 1,400 MHz. Bridle, A. H. (Queen's Univ., Kingston, Ont.); Davis, M. M.; Fomalont, E. B.; Lequeux, J. Nature (London) Phys. Sci.; 235: No. 59, 123-6(14 Feb 1972).

It was found that 1,400-MHz extragalactic radio source counts indicate that the exponent of the relation between number and flux density is only greater than 1.5 at very low source densities. (auth)

21165 3C 279: EVIDENCE FOR A NON-SUPERRELATIVISTIC MODEL. Dent, William A. (Univ. of Massachusetts, Amherst). Science; 175: No. 4026, 1105-6(10 Mar 1972).

Measurements of the variation of the total flux density of the quasi-stellar radio source 3C 279 provide evidence for an alternate model to explain the recently reported apparent source expansion rate of ten times the speed of light. (auth)

21166 PULSAR DISTANCES AND ENERGY. Basu, B.; Bandyopadhaya, R. (Jadavpur Univ., Calcutta). Stud. Cercet. Astron.; 16: No. 2, 169-76(1971).

The distances of pulsars were calculated on the assumption of $\langle n_e \rangle = 0.01\ \text{cm}^{-3}$. This value of $\langle n_e \rangle$ was taken as the most plausible value if partial ionization of the interstellar hydrogen by a high flux of low-energy cosmic rays is assumed. It has been shown that the pulsars so far discovered are all galactic and also that they are, in general, weak emitters—probably weaker than the Sun by three or four orders of magnitude. Although the pulsars are believed to be physically associated with supernovae, the fact that no known galactic supernova except the Crab nebula has been identified with a pulsar, casts doubt on such association. The association of NP 0532 with the Crab nebula may be only a positional coincidence. (auth)

21167 ADVANCED X-RAY OBSERVATORIES. Gursky, H. (American Science and Engineering, Inc., Cambridge, Mass.). Publ. Astron. Soc. Pac.; 84: No. 497, 99-109(Feb 1972).

The HEAO-C mission will combine all the following elements: large-aperture instruments; high-resolution optics; pointing at single regions for extended times; and high-resolution imaging detectors. The imaging capability of this mission is discussed in detail. Instruments on HEAO-C will also be capable of high-resolution spectroscopy, polarimetry, and measuring time variability. (W.D.M.)

21168 OBSERVATIONS OF RADIO VARIABLES AT 8000 MHz. Stull, Mark A. (Univ. of Michigan, Ann Arbor). Astron. J.; 77: No. 1, 13-16)Feb 1972).

Data are presented on 18 radio sources which show definite

or probable variations at 8000 MHz. A number of these have not previously been reported to be radio variables. (auth)

21169 COMPARISON BETWEEN THE RADIAL VELOCITIES OF OPTICAL AND RADIO INTERSTELLAR LINES IN THE SOUTHERN HEMISPHERE. Goniadzki, D. (Univ., Buenos Aires). Astron. Astrophys.; 17: No. 3, 378-84(Mar 1972).

The velocities of interstellar clouds of the southern hemisphere as determined by optical and radio measurements were studied. The correlation coefficient between the optical velocities (Ca^+ and Na^0 interstellar absorption lines) and the radio (neutral hydrogen line) velocities of components with velocities not greater than 20 km/s is 0.93, which shows that both measurements of each low-velocity (≤20 km/s) component refer to the same structure. The known distances of the stars used for the optical observations provide an upper bound for the distances of the clouds; it was found that several structures have motion different from those predicted by the rotation model. The optical velocities of high-velocity (>20 km/s) components do not in general coincide with neutral hydrogen velocities in the direction of the corresponding star. It was found that stars whose H^0 and optical velocities differed were located in dust clouds. (auth)

21170 DETECTION OF RADIO EMISSION FROM GX 9 + 1. Zaumen, W. (Massachusetts Inst. of Tech., Cambridge); Marthy, G. T.; Rappaport, S.; Hjellning, R. M.; Wade, C. M. Nature (London; 235: No. 5338, 378-9(18 Feb 1972).

Detection of a variable radio source in association with the x-ray source GX 9 + 1 is reported. Observations were made on Nov. 6, 1971 with the National Radio Astronomy Observatory three-element interferometer at 2,695 and 8,085 MHz. The variability of this source was similar to that observed for SCO X-1 and GX 17 + 2. The mean flux density at 2,695 MHz was $(8 \pm 3) \times 10^{-29}$ W/m²/Hz, and the source was smaller than 1 arc s. No stellar-like objects at the location of the radio source could be found using Sky Survey prints; this either implies considerable visual obscuration in the direction of GX 9 + 1 or that optical radiation is relatively weak. Two other celestial x-ray sources, GX 349 + 2 and GX 340 + 0, were also examined for radio emission during the period of observations of GX 9 + 1; these should be good candidates for radio emission since they are members of a complex of relatively stable x-ray sources, along the galactic plane and in the vicinity of the galactic center, including GX 9 + 1 and GX 17 + 2. (UK)

Solar Phenomena

Refer also to abstracts 21266, 21331, and 21332.

21171 HYDROMAGNETIC WAVES AND DISCONTINUITIES IN THE SOLAR WIND. Burlaga, L. F. (Goddard Space Flight Center, Greenbelt, Md.). Space Sci. Rev.; 12: No. 5, 600-57 (Dec 1971).

A general form of hydromagnetic theory appropriate for the solar wind is developed, and it is shown how the various special theoretical results can be unified and systematically derived from this general formulation. It is also shown that solar-wind plasma and magnetic-field observations support and can be organized by this theory. The emphasis is on the basic theoretical and experimental results and relations between them. 71 references. (W.D.M.)

21172 ESTIMATES OF THE NONRADIAT'VE ENERGY INPUT TO THE SOLAR CHROMOSPHERE FROM THE H^- EMISSION. Praderie, F.; Thomas, R. N. (Univ. of Colorado, Boulder). Astrophys. J.; 172: No. 2, 485-90(1 Mar 1972).

The inclusion of non-LTE effects in the computation of mechanical heating in a gray atmosphere changes previous LTE estimates by a factor of $4b_{H^-}$. (auth)

21173 VELOCITY OF THE SOLAR WIND AS DETERMINED FROM INTERPLANETARY SCINTILLATIONS. Jokipii, J. R.; Lee, L. C. (California Inst. of Tech., Pasadena). Astrophys. J.; 172: No. 3, 729-37(15 Mar 1972).

The "method of smooth perturbations" is used to derive the equations for interplanetary scintillation in a (statistically) spherically symmetric solar wind with constant wind velocity. The expressions, valid in the limit of small scintillation index, are used to discuss the relation between the radial wind velocity and the observed projected velocity of the scintillation pattern. It is found that the pattern velocity is systematically less than the wind velocity by a substantial fraction, depending on the radial variation of the density fluctuations. If the fluctuations δn_e fall off as $1/r^2$ the correction is 18%, whereas if $\delta n_e \propto 1/r$ the correction is 57%. The effects may be even more severe if the solar wind is not spherically symmetric. Application to various observations is discussed, and it is concluded that the case $\delta n_e \propto 1/r^2$ accounts well for discrepancies between direct and radio determinations of the solar-wind velocity. (auth)

21174 FORCED DIFFUSION OF SOLAR MAGNETIC FIELDS. Pneuman, G. W.; Raadu, M. A. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 172: No. 3, 739-48 (15 Mar 1972).

The observed latitude migration of solar magnetic features during the solar cycle is explained within the framework of a dynamic model employing subsurface horizontal forces. Consideration of the latitude distribution of the mean toroidal magnetic fields expected to be generated by differential rotation leads to the expectation of significant horizontal magnetic forces which tend to drive high-latitude features poleward and low-latitude features toward the equator. If this driving force is assumed to be resisted by the turbulent friction of solar materials as well as by pressure forces, migration velocities can be estimated. The calculated drift rates agree quite well with the latitude drifts observed for sunspots, filaments, unipolar magnetic regions, and coronal features. This "forced diffusion" mechanism differs most significantly from the random-walk process in that it is dynamic rather than kinematic, i.e., magnetic elements are systematically forced to the poles by the differential rotation itself. The overall estimated effectiveness of the mechanism indicates that it should be incorporated along with the random walk into solar dynamo models. (auth)

21175 OSCILLATIONS IN AN ISOTHERMAL ATMOSPHERE: THE SOLAR FIVE-MINUTE OSCILLATIONS. Worrall, Gordon (Univ. of Maryland, College Park. Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 172: No. 3, 749-53(15 Mar 1972).

An isothermal atmosphere, subject to pressure fluctuations at its base, responds very strongly at the frequency $\omega_g = (\gamma - 1)^{\frac{1}{2}} g/c$, regardless of the horizontal scale of the exciting fluctuations. Because of a misinterpretation of a result obtained by Lamb it has previously been supposed that this response occurs at the frequency $\omega_g = \gamma g/2c$. (auth)

21176 ABSORPTION SPECTRUM OF S I IN THE VACUUM ULTRAVIOLET. Tondello, Giuseppe (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 172: No. 3, 771-83 (15 Mar 1972).

An analysis of the absorption spectrum of S I in the region λλ1830 to 900 resulted in the classification of more than 100 new lines, of which some, above the ($^4S^0$) first ionization limit, are strongly autoionized. Parameters are given for the autoionized lines and for the continuous photoionization cross section of S I. In the experiment, atomic sulfur was produced by a flash-pyrolysis method, i.e., irradiating the sample with a strong flux of light from a discharge flash lamp. A Garton source provided the continuum. (auth)

21177 EFFECT OF RESONANCE-LINE TRANSFER ON HYDROGEN IONIZATION. Beebe, H. A. (New Mexico State Univ., Las Cruces); Milkey, R. W. Astrophys. J.; 172: No. 3, L111-14(15 Mar 1972).

Non-LTE calculations were carried out on a model of a hydrogen atom in the solar chromosphere. In evaluating the assumption of detailed balance in Lyman-α, it was found that radiative transfer with a Voigt profile alters the hydrogen ionization equilibrium above a Lyman-continuum optical depth of about 10^4. (auth)

21178 OSCILLATORY MOTIONS IN A SOLAR PROMINENCE OF MARCH 26, 1964. Shpitalnaya, Alexandra A. (Pulkovo Main Astronomical Observatory, USSR); Tifrea, Emilia. Stud. Cercet. Astron.; 16: No. 2, 131-9(1971).

It is suggested that the knots (dashes) of the prominence may be associated with the plasmoids generated by the instability in a pinch-tube plasma. The successive plasmoids are shot from the instability region at velocities of 60 and 123 km/sec. The same case is illustrated where the velocity of escape of plasmoids is 97, 183, 284 km/sec (quantical velocity). The energy at the moment of the plasmoid flight was evaluated at 2.10^{28} ergs, comparable with the case of small flares. (auth)

21179 ERUPTIVE PHENOMENA DURING THE PERIOD NOVEMBER 14–16, 1970 IN THE F-TYPE SUNSPOT GROUP AND THEIR GEOPHYSICAL CORRELATIONS. Maris, Georgeta; Nicolescu, Simona (Astronomical Observatory, Bucharest). Stud. Cercet. Astron.; 16: No. 2, 207-14(1971). (In Rumanian).

The H-alpha filtergrams of the eruptive phenomena in a large sunspot group during the period November 14–16, 1970, associated with radio, x-ray, solar protons, and ionospheric events

were analyzed. The region of the flares was characterized by the presence of a "delta" magnetic configuration. The flare of November 15 was associated with the active dark filament. In the case of filament activation associated with the flare, the propagation velocity was of about 1200 km/sec. The correlation in time between various examined aspects of the solar-active regions seems to indicate that the sequence for the beginning of the different phenomena is, in general: optical flares, x-ray events, and radio events. (auth)

21180 SOLAR NEUTRINOS. Bahcall, J. N. (Inst. for Advanced Study, Princeton, N. J.). pp 243-6 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

Five questions on solar-neutrino astronomy of particular interest to high-energy physicists are considered. Aspects of the theory that seem most likely to be wrong and experiments that seem most likely to help improve the theory are discussed. (W.D.M.)

21181 RADIATIVE RELAXATION OF SOUND WAVES IN AN OPTICALLY THIN ISOTHERMAL ATMOSPHERE. Souffrin, P. (Observatorie, Nice). Astron. Astrophys.; 17: No. 3, 458-67(Mar 1972).

The radiative damping of oscillatory modes in an optically thin isothermal atmosphere was investigated within the approximation of Newton's law of cooling. Special attention was paid to vertical modes sustained by harmonic boundary conditions and to the discussion of the validity of the adiabatic and isothermal limiting cases. The influence of relaxation on the response of an infinite model to an applied body-force was studied in the one-dimensional case. Application to solar conditions indicated that the dissipation in the chromosphere has little effect on the dynamics of the chromospheric oscillation. (auth)

21182 SIGNIFICANCE OF THE EXISTENCE OF CLASSES FOR VISIBLE CORONAL LINES. Magnant, F.; Fort, B.; Flower, D. R. (Observatoire, Meudon, France). Astron. Astrophys.; 17: No. 3, 403-9(Mar 1972).

It is shown that there exists an almost linear relationship between the logarithm of ionization potential of a given ion and the logarithm of the temperature at which the ionization function of this ion reaches its maximum. This enables ions to be classified according to their ionization potential. This classification, coupled with the fact that the ionization curves are in most cases very sharply peaked, explains the existence of empirically defined classes for visible coronal lines. The classification suggests a comparison between lines belonging to ions of different elements having similar ionization potentials and ionization functions. (auth)

Galaxies

Refer also to abstract 21145.

21183 REDSHIFTS OF TWENTY RADIO GALAXIES. Burbidge, E. Margaret; Strittmatter, P. A. (Univ. of California, San Diego). Astrophys. J.; 172: No. 2, L37-40(1 Mar 1972).

Spectroscopic observations and redshifts of 20 radio galaxies obtained with the Lick 120-inch (305 cm) telescope are presented. Ten of the radio galaxies are from the 3C R catalog, and the remainder are from the 4C, 5C, Ohio, and Parkes catalogs. (auth)

21184 EVOLUTION OF A STATIONARY DISK OF STARS. Hohl, Frank (Langley Research Center, Hampton, Va.). J. Comput. Phys.; 9: No. 1, 10-25(Feb 1972).

An improved potential solver for calculating the gravitational potential of isolated disk galaxies is presented. The potential solver is used to investigate the evolution of initially stationary axisymmetric disks of stars for various values of the initial velocity dispersion. (auth)

21185 SURVEY OF LOCAL INTERSTELLAR HYDROGEN FROM OAO-2 OBSERVATIONS OF LYMAN ALPHA ABSORPTION. Savage, Blair D. (Washburn Observatory, Madison, Wis.); Jenkins, Edward B. Astrophys. J.; 172: No. 2, 491-522(1 Mar 1972).

The Wisconsin far-ultraviolet spectrometer aboard OAO-2 observed the wavelength region near 1216 Å for 69 stars of spectral type B2 or earlier. From the strength of the observed interstellar Lα absorption, column densities of atomic hydrogen were derived over distances averaging 300 pc away from the Sun. Measurements of the equivalent widths of this absorption were found to be inappropriate for deducing column densities because of the blending of nearby strong stellar lines by the 12 Å wide instrumental profile of the OAO. Instead, the OAO data were compared with synthetic ultraviolet spectra, originally derived from earlier higher-resolution rocket observations, which were computer processed to simulate the effects of absorption by different amounts of hydrogen followed by the instrumental blending. An average volume density $n_H = 0.6$ atoms cm^{-3} was derived using all the stars. For stars nearer the Sun ($r < 140$ pc) $n_H = 0.25$ atoms cm^{-3}. The fact that no stars were observed much beyond 1 kpc precludes any general information on large-scale galactic structure. However, there is evidence for a pronounced enrichment of gas toward a number of stars in Scorpius, and a general deficiency seems to exist in the $180° < l^{II} < 270°$ sector. A comparison of Lα column densities with those derived from observations of 21-cm emission shows a very poor correlation, which demonstrates the importance of the unavoidable differences in sampling geometry. The Lα column densities correlated reasonably well with D-line, H- and K-line, and color-excess measurements for the respective stars, and the average ratios $\langle N_{Na\,I}/N_{H\,I}\rangle = 3.5 \times 10^{-9}$, $\langle N_{Ca\,II}/N_{H\,I}\rangle = 2.5 \times 10^{-9}$ and $\langle N_H/E(B-V)\rangle = 5 \times 10^{21}$ atoms cm^{-2} mag^{-1} were obtained. For assumed ionization equilibrium constants and a model for the interstellar medium, the observed ratios imply the total abundances $\langle Na/H\rangle \approx 2.3 \times 10^{-7}$ and $\langle Ca/H\rangle \approx 6.8 \times 10^{-9}$. For a very recent grain model $\langle \rho_{H\,I}/\rho_{dust}\rangle \approx 100$ from the $\langle N_H/E(B-V)\rangle$ relation. (auth)

21186 INTERNAL KINEMATICS OF THE 30 DORADUS NEBULA IN THE LARGE MAGELLANIC CLOUD. Smith, Malcolm G. (Cerro Tololo Inter-American Observatory, La Serena, Chile); Weedman, Daniel W. Astrophys. J.; 172: No. 2, 307-17(1 Mar 1972).

A pressure-scanned, Fabry–Perot interferometer having a spectral resolution of 11 km s^{-1} was used to observe 200 emission-line profiles and radial velocities in the giant 30 Doradus Nebula. Radial-velocity differences of up to 80 km s^{-1} were found between different components of the nebula. The most probable velocity of gas motions was 25 km s^{-1}, almost twice as rapid as in any other LMC H II region. However, the nebula shows no overall motion with respect to the Population I rotation curve for the LMC, so it was concluded that the rapid internal motions are produced by sources within the nebula, probably by the large concentration of Wolf–Rayet stars. The loops and filaments of gas seen in the nebula appear to move coherently; gas motions within the filaments are typically only one-third as rapid as the differential motions between filaments. (auth)

21187 STATISTICS OF STELLAR DYNAMICAL SYSTEMS. MMiller, R. H. (Univ. of Chicago). Astrophys. J.; 172: No. 3, 685-8(15 Mar 1972).

The phase space (μ-space) is divided into cells with at most one occupant per cell by the pair correlation recently reported. The exclusion leads to a statistics similar to the Fermi–Dirac statistics. The cell size (analog of the Planck constant) depends on the total energy and on the number of particles, becoming large in systems with many particles. When values appropriate to the Galaxy are inserted into the empirical forms suggested by the numerical experiments, no degeneracy is indicated. (auth)

21188 INTERGALACTIC CLOUDS IN THE COMA CLUSTER. Goldsmith, Donald; Silk, Joseph (Univ. of California, Berkeley). Astrophys. J.; 172: No. 3, 563-75(15 Mar 1972).

Recent observations in several different spectral regions can be used to set definite limits on the existence of an intergalactic medium within the Coma Cluster of galaxies of density sufficient to bind the cluster gravitationally. A theoretical discussion of the stability of this gas is presented and it is concluded that a narrow range of parameters may exist over which intergalactic clouds can account for the virial discrepancy in the Coma Cluster. The recent discovery of x radiation from the central region of the Coma Cluster is interpreted as thermal emission from the (hotter) intercloud medium. Finally, Lα observations are proposed as the crucial test of the hypothesis of intergalactic clouds. 45 references. (auth)

21189 ABSENCE OF LYMAN-ALPHA EMISSION FROM THE COMA CLUSTER OF GALAXIES. Henry, Richard C. (Naval Research Lab., Washington, D. C.). Astrophys. J.; 172: No. 3, L97-100(15 Mar 1972).

The redshifted Lα flux from the Coma Cluster of galaxies is determined to be less than 6000 photons cm^{-2} s^{-1}, leading to severe (and perhaps fatal) new restrictions on hot ionized gas models for the gravitational binding of the cluster. (auth)

21190 HYDROGEN LINES IN MARKARIAN 6. Adams, Thomas F. (Univ. of Arizona, Tucson). Astrophys. J.; 172: No. 3, L101-3(15 Mar 1972).

Results of new observations are presented showing that the second component in the hydrogen lines in Markarian 6 was still present in April and November 1971. This is in conflict with Ulrich's report that the second component had disappeared. Even if Markarian 6 has not changed, the second component still provides strong evidence for large-scale mass motions. An attempt is made to relate the N galaxy 3C 390.3 and the Seyfert galaxy NGC 5548 to Markarian 6. (auth)

21191 SCATTERING BY ROUGH CYLINDRICAL PARTICLES. Shah, G. A.; Vardya, M. S. (Tata Inst. of Fundamental Research, Bombay). Nature (London) Phys. Sci.; 235: No. 58, 115-16 (7 Feb 1972).

It is stated that almost all the analytical theories of electromagnetic scattering so far presented for various-shape particles are concerned with smooth bodies of revolution; but the real scatterers, formed in random accretion of matter in space, are likely to have some degree of surface roughness that may significantly alter the scattering properties. A model is proposed here for a rough cylinder, analogous to that proposed by the authors for a rough sphere (Astrophys. Space Sci., 12: 455(1971)), and comparison is made with experimental data (Nature Phys. Sci., 230: 110 (1971)). It is concluded that extinction and polarization by rough particles can differ significantly, although not drastically, from that of the equivalent smooth particles in some spectral regions. An application is to interstellar grains. (UK)

21192 DISTRIBUTION OF GAS AND DUST IN M81. Connolly, Leo P.; Mantarakis, Petros Z.; Thompson, Laird A. (Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac.; 84: No. 497, 61-3(Feb 1972).

A new determination of M 81's inclination angle (58° ± 2°) allows one to obtain a face-on view of the galaxy in both dust and gas components. A logarithmic spiral is fitted to the dust diagram, and statistics on the gas distribution are presented. (auth)

21193 FORM TYPES FOR CLUSTERS OF GALAXIES. Bautz, Laura P. (Northwestern Univ., Evanston, Ill.). Astron. J.; 77: No. 1, 1-3(Feb 1972).

Rich clusters of galaxies were classified by the relative contrast between the brightest member and the typical bright galaxy population of the cluster. This parameter was not correlated with richness. A list of 111 newly classified Abell clusters is presented. (auth)

21194 RADIAL VELOCITIES OF GALAXIES. Chincarini, Guido (Univ. of Texas, Austin); Rood, Herbert J. Astron. J.; 77: No. 1, 4-8(Feb 1972).

A list of radial velocities of galaxies derived from spectrograms obtained primarily in 1970 with the Carnegie image tube Cassegrain spectrograph attached to the KPNO 84-inch telescope is presented. The plates were measured on a two coordinate Grant comparator. The text describes the reduction procedures. Curvature and residual zero-point corrections were found to be small or negligible. The sample of galaxies is nonhomogeneous, representing parts of various special investigations on groups and clusters of galaxies. (auth)

21195 CLUSTER OF GALAXIES ABELL 1413. Noonan, Thomas W. (Brockport State Coll., N. Y.). Astron. J.; 77: No. 1, 9-12(Feb 1972).

The cluster Abell 1413 at a redshift of 0.143 shows an effect which may be interpreted as a luminosity segregation, indicating that this property probably persists over look-back times of order 0.14 of the inverse of the Hubble constant. The cluster has the same richness as the Coma cluster but only about 60% of the radius, unless what appears to be the brightest member is really a foreground galaxy. (auth)

21196 CALCIUM II K-LINE PROFILES IN FRONT OF DISTANT OB STARS. Rickard, James J. (California Inst. of Tech., Pasadena). Astron. Astrophys.; 17: No. 3, 425-31(Mar 1972).

Profiles of the Ca II K-line were observed in 26 stars with the Fabry–Perot pressure-scanned interferometer attached to the Mount Wilson coudé spectrograph. The velocity resolution was 6 km/s. 14 stars were at low latitude ($|b| < 6°$) in the anticenter direction; and 12 were high-latitude stars ($|b| > 13°$). A comparison with 21-cm H I line profiles and K-line profiles was also made. In the anticenter direction there was good correlation between the shapes of the K-lines and 21-cm lines. The data were consistent with a quiescent interstellar medium showing no peculiar or streaming motions out to approximately 1500 pc from the sun. The high-latitude K-lines showed many negative velocity features correlated in velocity with the H I gas known as IVC's. The correlation between the shapes of the K-lines and 21-cm lines was not as good as at low latitudes. The minimum z-distance of 600 pc was found for the appearance of negative velocity components correlated with the IVC's. But no simple dependence of velocity and z-distance was evident. (auth)

21197 21-cm LINE STUDY OF THE PECULIAR GALAXY NGC 5253. Bottinelli, L.; Gouguenheim, L.; Heidmann, J. (Observatorie, Meudon, France). Astron. Astrophys.; 17: No. 3, 445-9(Mar 1972).

The peculiar galaxy NGC 5253 was observed in the 21-cm line with the Nançay radio telescope. The properties of its H I gas content are characteristic of an early-type galaxy, most probably lenticular. This type is consistent with the large-scale stellar distribution. Thus, NGC 5253 does not appear as a self-contradictory galaxy regarding its morphological type; however, it is peculiar because of its unusual nucleus with the intense emission complex studied by Welch. (auth)

21198 ORIGIN OF THE MAGNETIC FIELD IN THE EXTENDED RADIO AND X-RAY SOURCE IN THE COMA CLUSTER. Perola, G. C.; Reinhardt, M. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys.; 17: No. 3, 432-6(Mar 1972).

The extended x-ray source in the central part of the Coma Cluster can be explained by inverse Compton scattering of the relativistic electrons in the extended radio source that coincides with it in position and dimensions. The average magnetic field strength in this source is then 10^{-7} G. Two possibilities of the origin of the field are considered. (I) It is condensed primaeval field. Using independent estimates of its field strength, the amount of ionized gas in the central condensation of the Coma Cluster is derived, which turns out to be less than the mass necessary to stabilize the cluster. The stability problem of this hot gas is discussed. (II) It is a relict of radio sources in the cluster active in the past. This is discussed in some detail, and turns out to be a plausible explanation. But again there cannot be enough gas to stabilize the cluster, unless it is concentrated in small scale condensations. Both explanations turn out to be possible. High-resolution polarization measurements at different wavelengths of the extended radio source, and the small diameter sources behind it, could give a clue to the gas density, and might help to discriminate between the two models of the origin of the field. (auth)

21199 HIGH RESOLUTION RADIO CONTINUUM SURVEY OF M51 AND NGC 5195 AT 1415 MHz. Mathewson, D. S.; van der Kruit, P. C.; Brouw, W. N. (Sterrewacht, Leiden). Astron. Astrophys.; 17: No. 3, 468-86(Mar 1972).

The results are reported of a survey at 1415 MHz of M51 and its companion, NGC 5195, with the aperture-synthesis type radio telescope at Westerbork, which has a resolution corresponding to a linear distance of 450 pc at the distance of M51 and a sensitivity of 1×10^{-29} W m^{-2} Hz^{-1}. (W.D.M.)

Cosmology

Refer also to abstracts 21388, 21466, and 21512.

21200 LIMIT ON LINE EMISSION IN THE DIFFUSE X-RAY BACKGROUND. Toor, A.; Price, R. E.; Seward, F. D. (Univ. of California, Livermore). Astrophys. J.; 172: No. 2, L73-5 (1 Mar 1972).

Diffuse x-ray background data from an extended region in the galactic plane and near the South Galactic Pole do not exhibit an enhancement in the spectrum near 7 keV. (auth)

21201 LIMITS ON THE LOCAL DEVIATION OF THE UNIVERSE FROM A HOMOGENEOUS MODEL. Sandage, Allan; Tammann, G. A.; Hardy, Eduardo (Hale Observatories, Pasadena, Calif.). Astrophys. J.; 172: No. 2, 253-63(1 Mar 1972).

If the Hubble constant is determined by some means in the redshift range $4000 < cz < 15{,}000$ km s^{-1}, are corrections needed to obtain an "asymptotic" value which has a global significance? The size of such a correction depends on the effect of departures from homogeneity on the velocity field. Limits were set on this effect and on departures from spatial homogeneity in two ways. (1) Analysis of perturbations on the velocity field of 30 local ($cz < 10{,}000$ km s^{-1}) clusters of galaxies was made by testing departures of the slope A of the redshift–magnitude relation $m = A \log cz + B$ from the value of 5. The departure was less

than 1 σ for all solutions. Using a dynamical model by Haggerty and Wertz, limits were set on the density contrast. The results when compared with different results by de Vaucouleurs for field galaxies are puzzling, and it is thought that the problem remains open. Because of the obvious local clumping of matter on a scale of 20 Mpc, such lack of perturbation, if correct, could require that $q_0 \simeq 0$. In any case, the agreement of the cluster data with the prediction from the homogeneous model, in the $z \to 0$ limit, requires that no correction of H_0 should be made. (2) New data on galaxy counts in the Catalogue of Galaxies and Clusters of Galaxies were obtained, and are tabulated for the north and south polar caps to $m_{pg} = 15.7$. These data, together with the galaxy counts of Mayall, Shane and Wirtanen, and Hubble put limits on any systematic deviation from large-scale homogeneity. Following Wertz, if a systematic deviation is characterized by $N(r) \propto r^{-\theta}$, the limit on θ is $\theta = -0.115 \pm 0.030$, which does not differ significantly from $\theta = 0$. A hierarchical model suggested by de Vaucouleurs with $\theta = 1.7$ is not confirmed. The result is the same as that which was obtained from the deep surveys of Hubble and Mayall. (auth)

21202 MODELS FOR THE COSMIC EVOLUTION OF RADIO GALAXIES AND QUASARS. Bahcall, John N. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Astrophys. J.; 172: No. 2, 265-82(1 Mar 1972).

The observational distinctions between various explanations of radio-source evolution are exhibited with the aid of simple models. These models are derived by using a formalism that enables one to calculate, on the basis of explicit hypotheses, the number of sources that are present at a given cosmic time. Particular attention is given to "ultraconservative" and "symmetric" models. In the ultraconservative models, the total number of galaxies that have been radio galaxies is constant in time (after some creation period), but most of what are today "normal" galaxies were powerful radio sources when they were younger. In the symmetric models, the evolution of radio galaxies and quasars is treated in the same way by using coupled equations that suggest a mean life for the primordial bright ellipticals of 10^9 years. Both the ultraconservative and the symmetric models suggest that there may be significant departures from the usually predicted relations in the diagram of apparent magnitude versus redshift for large-redshift radio galaxies because the usual relations are calculated for objects with typical luminosities that are independent of cosmic time. The observational basis for some of the evolutionary models considered is strengthened by the application of the luminosity–volume test to an essentially complete sample of 3C R radio galaxies for which redshifts and accurate optical magnitudes are available. The results confirm and strengthen the conclusions of previous investigators regarding the lack of evolution among radio galaxies with an intrinsic power at 178 MHz of less than 10^{26} W Hz^{-1}. (auth)

21203 ELECTROMAGNETIC FIELD OF A PARTICLE MOVING IN A SPHERICALLY SYMMETRIC BLACK-HOLE BACKGROUND. Ruffini, R. (Joseph Henry Physical Labs., Princeton, N. J.); Tiomno, J.; Vishveshwara, C. V. Lett. Nuovo Cim.; 3: No. 5, 211-15(29 Jan 1972).

The theoretical basis for the analysis of the electromagnetic radiation emitted by a charge moving in a gravitational field of spherically symmetric black holes is presented. Specifically, a black hole with $Q \leq M$ is considered in the Reissner–Nordström metric, where M is the mass and Q the charge of the given background metric. (L.M.T.)

21204 SELF-SCATTERING OF A SMOOTH TOROIDAL GRAVITATIONAL PULSE WAVE. Marder, L. (Univ. of Southampton, Eng.). Nature (London); 235: No. 5338, 379-80 (18 Feb 1972).

It is stated that important information in astronomy may be forthcoming by observations of gravitational waves; but the nonlinearity of gravitational field equations in general relativity makes it difficult to estimate effects that might arise through collisions between waves, even when the nature of the impinging waves is known. In general, direct superposition of solutions for individual waves will lead to violation of the vacuum equations, and thus determination is necessary, in a particular situation, whether there exists a valid vacuum solution, nonsingular in the wave region, which represents the gravitational field before, during, and after the collison, or whether the eventual formation of physical singularities is predicted. In this connection reference is made to the work of Penrose and Khan (Rev. Mod. Phys., 37: 215(1965) and Nature, 229: 186(1971)). Brief details are given of the wave zone in a new exact solution for a smooth axisymmetric toroidal pulse emanating from a ring. If the degree of smoothness is sufficient, the solution remains valid without development of a singularity during, or beyond, the self-collision that occurs on the axis. Such a solution might give an insight into collision processes in other modes since the radiation zone is bounded. (UK)

21205 TRANSPARENCY OF EXTRAGALACTIC SPACE TO VERY-HIGH-ENERGY PHOTONS. II. Bonometto, S. A. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Lucchin, F. Lett. Nuovo Cim.; 2: No. 25, 1299-1304(18 Dec 1971).

It is shown that the cascade effect will give very relevant changes in the effective transparency of the Universe. The maximum transparency, at the present epoch, for photons of energy about 10^{18} to 10^{19} eV, is $\sim 10^{26}$ cm. (W.D.M.)

21206 REDSHIFT CUTOFF AND EVOLUTION EFFECT AT ORIGIN OF METAGALACTIC BACKGROUND RADIATION. Dautcourt, G. (Zentralinstitut fuer Astrophysik, Potsdam, Ger.). Monatsber. Deut. Akad. Wiss. Berlin; 13: No. 6, 417-21(1971). (In German).

The intensity of metagalactic background radiation arising from physical processes in intergalactic matter or resulting from the superimposed radiation of discrete sources depends upon the "strengths" of evolution effects: In the case of "power law radiation" above a critical strength, which depends upon the spectral index, there is a strong dependence on the cutoff redshift z^*, where the radiation production commences. The radiation observed at the present time then stems from periods with very large redshifts and almost any amount of radiation flux could be obtained by increasing z^*. Below this threshold the radiation comes mainly from rather recent stages of metagalactic evolution; its intensity is almost independent of the cut-off redshift z^* and usually much smaller. (auth)

21207 CURRENT PROBLEMS IN COSMOLOGY. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). pp 247-55 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

An attempt is made to show that the theory of the early (10^5 years) Universe presents fundamental problems, not only in general relativity, but also in hydrodynamics, statistical mechanics, and elementary-particle physics. The general features of the early evolution of the Universe, about which cosmologists are pretty much in agreement, are reviewed and assorted open problems are discussed. (W.D.M.)

Planetary Phenomena

21208 COMPOSITION AND STRUCTURE OF PLANETARY ATMOSPHERES. Hunten, Donald M. (Kitt Peak National Observatory, Tucson, Ariz.). Space Sci. Rev.; 12: No. 5, 539-99(Dec 1971).

Discussion is confined to lower atmospheres; thus, photochemistry and ionization are ignored, along with regions where they are important. The complications of horizontal transport and weather are not considered. Existing information is critically reviewed for the planets Mars, Venus, and Jupiter, about which most is known; other planets are briefly discussed. 157 references. (W.D.M.)

21209 LUNAR SOLID-TYPE AND LIQUID-TYPE MATERIALS AND RARE EARTH ABUNDANCES. Masuda, A. (Science Univ., Tokyo). Nature (London) Phys. Sci.; 235: No. 59, 132-3(14 Feb 1972).

Chemical analysis of lunar samples showed that the rare-earth patterns are quite different in materials from Mare Tranquillitatis and Oceans Procellarum. Such a difference is discussed in relation to the evolution and genetic relationship of lunar materials. Reference is made to the model of Masuda and Matusi for RE abundance variation (Geochim. Cosmochim. Acta, 30: 239(1966)); this model predicts that terrestrial materials may be classified into primary liquid-type and primary solid-type materials, and it seems that this model is also relevant to the Moon. For reasons given, only La, Nd, and Sm are suitable rare earths for use in determining the genetic type of lunar materials, and the considerations discussed are applied to various Apollo samples. It is considered significant that typical solid-type materials of the Moon have been found in a mare area only; this may mean that solid-type materials were derived from the uppermost lunar mantle by catastrophic impact followed by complete melting. Also, the discovery of liquid- and solid-type materials related in a conjugate manner suggests that, although anorthosite was reported by the Apollo 15 mission, it is not the most representative constituent of lunar highland. (UK)

21210 CARBON CHEMISTRY OF APOLLO 14 SIZE-FRACTIONATED FINES. Holland, P. T.; Simoneit, B. R.; Wszolek, P. C.; McFadden, W. H.; Burlingame, A. L. (Univ. of California, Berkeley). Nature (London) Phys. Sci.; 235: No. 58, 106-8(7 Feb 1972).

It is stated that, whereas total C measurements of crystalline lunar rocks have revealed only low concentrations of C (10 to 50 ppM), the breccias and fines in general show higher C concentrations (up to 200 ppM). This C is more concentrated in the finer fractions and is correlated with the noble-gas content of the solar wind. It has been postulated that most of the C associated with the fines and breccias originated in the solar wind. Studies on several Apollo 12 and 14 samples are described that confirm the presence of CH_4 and C_2H_6 in the fines and breccias and that show that the concentrations are dependent on particle size. This would be expected if the gases are located in the surface of the grains, and the results strongly support the suggestion that solar-wind activity is a source of CH_4 in lunar samples. Details are given of the experimental technique adopted. Dissolution was in DF and identifications and quantitative estimation of the gases were by high-resolution mass spectrometry and by mass chromatography. Pyrolysis was carried out directly into the ion source of a mass spectrometer with LOGOS computer data acquisition. Yields are tabulated for CD_4, CH_4, ^{20}Ne, ^{36}Ar, C_2H_6, DCN, D_2S, and CS_2. The yields of ^{20}Ne and ^{36}Ar, derived from the solar wind, provide a measure of the influence of the solar wind on the soil. A linear correlation of the surface area parameter 1/r with contents of CH_4, ^{20}Ne, and ^{36}Ar was found, showing that these components are associated with the surface of the grains. Reaction of protons in the solar wind with C in the fines has been suggested as a source of the CH_4, and this is supported by the surface area dependence. For C_2H_6 a higher dependence than r^{-1} was indicated. Mechanisms are suggested for formation of this gas and also for CH_4. A short discussion is also included on the part possibly played by meteoritic material in lunar carbon chemistry. With regard to DCN, D_2S, and CS_2 it is considered that solar-wind interactions may introduce the protobiologically important C—N and C—S bonds into the surface of the lunar fines. The role of carbides is also discussed. (UK)

21211 SIMULATION STUDY OF LUNAR CARBON CHEMISTRY. Pillinger, C. T. (Univ. of Bristol, Eng.); Cadogan, P. H.; Eglinton, G.; (and others). Nature (London) Phys. Sci.; 235: No. 58, 108-9(7 Feb 1972).

Some laboratory studies are described that were designed to provide evidence to support the suggestion that solar-wind implantation plays a significant role in the synthesis of hydrocarbons in lunar materials, and also for the suggestion that solar-wind implantation and meteoritic impact are a likely origin for carbides. Carbon and hydrogen ionized species ($^{13}C^+$, D_2^+) were implanted into various targets, including lunar fines. Irradiation was in an isotope separator to doses of 5×10^{15} atoms/cm^2 $^{13}C^+$ or 1×10^{18} mol/cm^2 D_2^+, at fluxes of 3×10^{12} atoms/s and 1.4×10^{14} nwl/s, respectively, and the labelled products released by acid dissolution or pyrolysis of the implanted targets were measured by low-resolution mass spectrometry and gas chromatography. Beam energies ($^{13}C^+$ 13 keV per atom; D_2^+ 10 keV per mol) were similar to those estimated for the solar wind (1 keV per nucleon). The simulation was only approximate in that species were implanted consecutively and high fluxes were employed to shorten the time scale. The results showed that CH_4 was synthesized in the fines targets either completely or partly from the irradiating species; also that carbide was synthesized in the metal targets (Al, Fe) and possibly also in the fines targets. No ^{13}CO or $^{13}CO_2$ was detected by pyrolysis (800°C) of the lunar fines targets, but $^{13}CD_4$ and $^{12}CD_4$ were evolved below 500°C. The following inferences for lunar surface carbon chemistry were drawn from the preliminary data: H from the solar wind and C from the solar wind, or already present from another source, may react to form CH_4; C from the solar wind may react with a component in the fines, probably Fe, to produce carbide; and CO and CO_2 from pyrolysis of the fines at 800°C should not contain C from the solar wind. Evidence was also obtained suggesting that the meteoritic contribution to lunar carbide may be greater than previously supposed. Further studies are indicated to provide information about other irradiation products and the reaction mechanisms of the irradiating species; of particular interest would be synthetic studies by irradiation with C, N, O, and H, which are relatively abundant in the solar wind. It is concluded that implantation effects occurring on the lunar surface have general implications concerning the synthesis of molecules in interplanetary and interstellar dust. (UK)

21212 EARTH SATELLITES AND THE GRAVITATIONAL POTENTIAL. Eberst, R. D. (Royal Observatory, Edinburgh). Nature (London) Phys. Sci.; 235: No. 59, 130(14 Feb 1972).

It is stated that analysis of the orbit of the artificial Earth satellite Ariel 3 at the Royal Aircraft Establishment, Farnborough, Eng. (Nature Phys. Sci. 231: 168(1971)) has shown that determinations of the 15th-order harmonics of the Earth's gravitational potential can be made if the analysis is carried out for the period when the orbit passes through resonance with these harmonics, and several satellites have orbits suitable for such studies. The Satellite Tracking Section at Edinburgh has written a computer program (LOOK 4A 15) that checks the orbits of about 360 artificial Earth satellites in this connection; this program enables a decision as to which objects are of interest and for what periods they should be observed for study of the resonance effect. The first run of this program was made in October 1971 and results are briefly described, together with those of some later runs. (UK)

21213 EQUATIONS FOR 15th ORDER HARMONICS IN THE GEOPOTENTIAL. King-Hele, D. G.; Hiller, H. (Royal Aircraft Establishment, Farnborough, Eng.). Nature (London) Phys. Sci.; 235: No. 59, 130-1(14 Feb 1972).

Reference is made to Gooding's equations (Nature Phys. Sci., 231: 168(1971)) for the 15th-order coefficients in the Earth's gravitational potential derived from changes in the orbital inclination as the satellite Ariel 3 passed through 15th-order resonance. The orbit of Ariel 3 was inclined at 80.2° to the equator and it is stated that, in order to obtain values of the individual coefficients, equations derived from resonant satellites at other inclinations are required, for which the numerical coefficients in the equations are very different. An analysis of the orbit of Transit 1B, launched in April 1960 with initial inclination 51.3° and passing through 15th-order resonance in 1962 is described. Although the available observations are few in number and poor in accuracy, it was possible to show that a large decrease in inclination occurred in 1962, and from the data equations were obtained for the above coefficients. Equations considerably more accurate should become available after analysis of the changes in inclination of satellites due to become resonant in the next few years, leading to better determination of the Earth's gravitational field, and opening the way to more stringent tests of theories of the Earth's interior. (UK)

21214 EFFECTIVE THICKNESS OF THE MOON'S RADIOACTIVE LAYER. Troitskii, V. S. (Scientific-Research Radiophysics Inst., Gorky, USSR). Solar Syst. Res. (USSR) (Engl. Transl.); 4: No. 4, 184-6(Oct-Dec 1970).

Translated from Astron. Vestn.; 4: No. 4, 222-5(Oct-Dec 1970).

On the basis of experimental data on (a) the total content of radioactive elements in the body of the Moon, as determined by radio-astronomical methods, and (b) the concentration of radioactive elements on the Moon's surface, as obtained by the Apollo-11 mission, it is shown that the effective thickness of the radioactive layer is 60 to 70 km. This value is 1.5 to 2 times as large as the value obtained from calculations based on the thermal history of the Moon. The causes of the divergences are discussed. (auth)

21215 MEASUREMENTS OF THE RADIO EMISSION OF MARS AT 8.22 mm AND ESTIMATE OF THE THERMAL AND ELECTRIC PARAMETERS OF THE PLANET'S SURFACE. Vetukhnovskaya, Yu. N.; Kuz'min, A. D.; Losovskii, B. Ya. (Lebedev Inst. of Physics, Moscow). Solar Syst. Res. (USSR) (Engl. Transl.); 4: No. 4, 190-7(Oct-Dec 1970).

Translated from Astron. Vestn.; 4: No. 4, 231-40(Oct-Dec 1970).

Measurements of the radio emission of Mars were made in June 1969 with the 22-m radio telescope of the P. N. Lebedev Physics Institute of the Academy of Sciences of the USSR. The measurements were made at a wavelength of 8.22 mm. A high-sensitivity radiometer made it possible to reduce both the random and systematic errors in the measurements. The ratio of the brightness temperatures, averaged over the visible disc, of Mars $\overline{T}_{b\sigma}$ and Jupiter $\overline{T}_{b\mathfrak{Z}}$ was found to be 1.22 ± 0.04. Assuming $\overline{T}_{b\mathfrak{Z}} = 144$°K, this corresponds to $\overline{T}_{b\sigma} = 176 \pm 5$°K. A calculation is made of the thermal conditions and the radio emission of Mars. It is shown that the measurements are in good agreement with a calculation for a surface having $\gamma = 250$, $\epsilon = 5$, and $\operatorname{tg} \Delta/\rho \leq 0.5 \cdot 10^{-2}$. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric

Refer also to abstracts 21179, 21254, and 21263.

21216 (JPRS-54975) DISTURBANCE OF IONOSPHERE BY RADIOWAVES. Gurevich, A. V. Translated from Geomagn. Aeron.; 11: No. 6, 953-60(Nov-Dec 1971). 11p. NTIS.

Under the influence of an alternating electrical field generated by powerful radio waves, the electrons of the ionospheric plasma become heated. This results in a disturbance of the concentration of electrons. It is shown that, at altitudes $z \lesssim 200$ km, the concentration of electrons N increases under the influence of the radiowave field ($\Delta N > 0$). In the range of $200 \lesssim z \lesssim (250$ to $300)$ km, the N disturbances are insignificant. However, in the area where the F layer is at the maximum ($z \sim 300$ to 400 km) and above, N disturbances increase again ($\Delta N < 0$). (J.C.W.)

21217 (N-72-10272) ROCKET MEASUREMENTS OF ION AND ELECTRON DENSITIES IN THE D AND LOWER E REGIONS NEAR SUNRISE. Pedersen, A.; Kane, J. A. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar 1971. 27p. (NASA-TM-X-67409; ESRO-SN-116). NTIS.

Positive-ion and electron densities were measured in the 75- to 110-km altitude range with the aid of two rockets launched from White Sands near sunrise. The solar zenith angles were 91 and 79°, respectively. The densities were derived from measurements made by an ion collector and from data obtained with a Faraday rotation technique capable of detecting electrons in the D region. It was found that in the 80- to 95-km altitude range, electron detachment from negative ions takes place mainly at zenith angles of less than 91°. The source of the high positive-ion density ($N^+ \sim 700/cm^3$) at an altitude of 75 km just before sunrise is presumed to be scattered Lyman-alpha radiation which is ionizing nitric oxide. (auth) STAR

21218 OBSERVATION OF PULSED PRECIPITATIONS OF ANISOTROPIC LOW ENERGY ELECTRON FLUX IN A STRUCTURED AURORA. Bosqued, J. M.; Cardona, G.; Reme, H.; Souleille, P. (Univ., Toulouse). Compt. Rend., Ser. B; 273: No. 21, 933-6(22 Nov 1971). (In French).

The angular distributions of the low-energy electrons of a structured aurora were measured from a Skylark rocket. They are very anisotropic and present a maximum along the geomagnetic-field lines. This result can be explained by a pulsed potential difference of a few kilovolts along these lines, which accelerates the electrons. (France)

21219 DETECTION OF WATER CLUSTER IONS AT THE HIGH LATITUDE SUMMER MESOPAUSE. Johannessen, A. (Max-Planck Inst. for Nuclear Physics, Heidelberg). Nature (London); 235: No. 5335, 215-17(28 Jan 1972).

Experiments launched from the Andoya Range on August 8, 1971 on a sounding rocket are described. The chief objective was to study the ion composition around the cold summer mesopause and its relation to ambient temperature, ionization production, and ionization loss rates. The most striking result was the large size of the water-cluster ions detected and the very rapid change in ion composition at about 85 km. Details are given of the experiments performed and results obtained. Water-cluster ions $H^+(H_2O)_6$ dominated below 84 km. Clusters of higher order were found with increasing height until an abrupt cutoff was reached at 84.5 to 86.0 km. Metal ions then appeared (chiefly Mg^+ and Fe^+) and NO^+ and O_2^+ emerged as the dominating species. The only exception to the cutoff of water-cluster ions was H_3O^+, which was detected in diminishing quantities up to 87.5 km. NO^+H_2O was also detected. The largest cluster found on the up-leg corresponded to $H^+(H_2O)_6$, and on the downleg ($H^+(H_2O)_5$). The rapid change in ion composition was accompanied by a steep increase in total-ion and electron densities. Since the ion-production function derived from the particle flux varied only slightly around 85 km, it is deduced that the enhancement in the charge distribution resulted from a reduction in the recombination efficiency of the dominant ions. (UK)

21220 SOLAR MODULATION OF GALACTIC COSMIC RADIATION. Rao, U. R. (Physical Research Lab., Ahmedabad, India). Space Sci. Rev.; 12: No. 6, 719-809(Jan 1972).

An attempt is made to present an integrated view of the solar modulation process that causes time variation of cosmic-ray particles. After briefly surveying the relevant large- and small-scale properties of the interplanetary magnetic fields and plasma, the motion of cosmic-ray particles in the disordered interplanetary magnetic fields is discussed. The experimentally observed long-term variations of different species of cosmic-ray particles are summarized and compared with the theoretical predictions from the diffusion-convection model. The effect of the energy losses due to deceleration in the expanding solar wind is clearly brought out. The radial density gradient, the modulation parameter and their long-term variation are discussed to understand the dynamics of the modulating region. The cosmic-ray anisotropy measurements at different energies are summarized. Both the diurnal and semi-diurnal components are shown to be practically time invariant. The rigidity dependence and the anisotropies during short-term variations such as Forbush decreases are discussed in terms of the proposed field models for the interplanetary-field structure and are compared with the observed rigidity dependence of long-term variations. The data pertaining to the 27-day corotating Forbush decreases and their association with enhanced diurnal variation are also presented. The relationship between the energetic storm particle events caused by the acceleration of particles in the shock fronts and the Forbush decreases caused by the exclusion of galactic particles by the enhanced field structure in the same fronts are clearly brought out. Thus, the recurrent increases at low energies and recurrent decreases at high energies may both be caused by the field structure in the shock front. In conclusion, the properties of the very-short-period fluctuations (18 to 25 cph) are summarized. (239 references) (auth)

21221 METHOD FOR DETERMINING IONOSPHERIC PLASMA PARAMETERS. Terina, G. I. (Inst. of Radio Engineering and Electronics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 618(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 726(1971).

As pulsed signals propagate in the ionospheric plasma their form becomes strongly distorted because of the inhomogeneous, irregular structure of the ionosphere, dispersion, etc. It was found earlier that signal distortions caused by dispersion and absorption are produced mainly by the parameters, dispersion, φ'', and absorption, $(-\ln R)'$. Expressions for these parameters were given by the author (Radiotekh. Elektron., 12: 123(1967)). To estimate φ'' and $(-\ln R)'$, the results of an experimental investigation were used from the distortions of pulsed signals during oblique ionospheric sounding on a 400-km path ($T \approx 10$ msec). The parameters were computed theoretically for an ionospheric model of four layers. Experimental determination of φ'' and $(-\ln R)'$ can serve as a means for estimating ionospheric characteristics such as the effective number of collisions in the lower layers and the electron-density gradient in the upper layers. (J.C.W.)

21222 NUMERICAL SOLUTION OF EQUATIONS OF THE GEOMAGNETIC DYNAMO THEORY. I. METHOD. Kropachev, E. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 585-90(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 690-6(1971).

A method in the form of a computer program for solving magnetohydrodynamic equations numerically for the core of the Earth is described. A combination of two methods is used for integration: the Fourier method and the method of finite differences. Using the Fourier method, the solution is represented analytically at any instant of time as a superposition of the spatial modes of the field, velocity, and temperature. The method of finite differences is used for integration with respect to time. (auth)

21223 ANNUAL GEOMAGNETIC FIELD VARIATIONS IN POLAR CAPS. Mansurov, S. M.; Mansurova, L. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 560-3(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 660-4(1971).

Evidence is presented that the annual geomagnetic field variation in polar caps is produced not only by the periodic variation of the angle between the ordered motion of solar plasma and the geomagnetic dipole axis but also by the interaction of the magnetic fields of space and of the earth. (auth)

21224 CHARACTERISTICS OF APERIODIC Dst AND THEIR POSSIBLE EXPLANATION BY THE INHOMOGENEOUS DISTRIBUTION OF ELECTRIC CONDUCTIVITY INSIDE THE EARTH. Afanas'eva, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 552-9(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 651-9(1971).

It is found that Dst has a longitudinal anomaly in the Pacific Ocean region. This anomaly does not fit into the main latitudinal Dst patterns and is associated with the asymmetric distribution of electric conductivity in the interior of the Earth. This distribution is represented by a system of induced currents in a spherical shell in the Earth's interior where the distribution of electric resistance ρ follows the law $\rho = \rho_0 [1 + E \sin \theta \cos (\lambda - \lambda_0)]$ where θ is the polar angle and λ is geomagnetic longitude. The constants E and λ_0 were determined from Dst observations at 28 magnetic observatories during February 25–28, 1956. The current system obtained has a characteristic feature, i.e., a region where the currents are crowded under the European and African continents and a region where they weaken at the longitudes of the Pacific Ocean. (auth)

21225 AURORAL X RAYS IN THE MIDNIGHT SECTOR DURING THE MARCH 8, 1970 STORM. Gasset, J.; Zhulin, I. A.; Cambou, F.; (and others) (Centre National d'Etudes Spatial, Toulouse. Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 541-4(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 637-42(1971).

X-ray bremsstrahlung was measured on a free, high-altitude balloon in the Arkhangel'sk region during the storm of March 8–9, 1970, the most intense of the current solar-activity cycle. The comprehensive experiment, performed at a network of stations and including measurements of auroras, ionospheric and geomagnetic-field disturbances, cosmic radio-noise absorption, etc., gives a general idea of the dynamics of precipitation of auroral particles and of their physical characteristics in the midnight sector. (auth)

21226 NITROGEN LUMINESCENCE SPECTRUM IN THE INFRARED REGION DURING EXCITATION OF PURE NITROGEN AND OF A MIXTURE OF NITROGEN WITH HELIUM BY FAST ELECTRONS. Danilevskii, N. P.; Popova, L. I.; Koval, A. G.; (and others) (Kharkov State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 535-40(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 630-6(1971).

The spectrum of nitrogen excited by electrons with an energy of 13 keV is investigated in the range 6500 to 11500 Å. The dependence of the intensity distribution of the N_2^+ ion within bands of the Meinel system on the temperature of nitrogen and its concentration in a helium–nitrogen mixture is studied. (auth)

21227 ELECTRODYNAMIC EFFECTS OF THE INTERACTION OF CHARGED-PARTICLE FLUXES WITH THE ATMOSPHERE. I. Osipov, N. K.; Pivovarov, V. G. (Inst. of Radio Engineering, Moscow. Inst. of Cosmophysical Investigations and Aeronomy, Yakutsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 527-31(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 619-25(1971).

Formulas are derived that determine the ionization rate, electron density, and the conductivity of the ionosphere during the interaction with the atmosphere of charged-particle fluxes with given parameters beyond the atmosphere: particle-flux density and energy, and pitch-angle distribution functions. The individual consequences of the interaction of auroral particle fluxes with the atmosphere are examined. (auth)

21228 LONG-DISTANCE PROPAGATION OF ATMOSPHERICS IN THE EARTH–IONOSPHERE WAVEGUIDE. Orlov, A. B.; Sternina, I. M. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 518-22(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 608-13(1971).

The phase velocities and attenuation coefficients, obtained from a spectral analysis of the waveforms of atmospherics and also by means of a narrow-band receiver, are presented for frequencies of 6 to 18 kHz. The experimental results are compared with theoretically computed data. The formation of atmospherics from pulses of individual modes at night in the frequency band 2 to 18 kHz is examined. (auth)

21229 CONJUGATE DISTURBANCES IN THE IONOSPHERIC F2 REGION. Ben'kova, N. P.; Bukin, G. V.; Chin Khong Tien (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 513-17(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 602-7(1971).

The vertical ionization profiles during disturbances at several pairs of magnetically conjugate stations are examined. It is found that during antiphased disturbances the variations in ionization density differ in the upper part of the F region and below this level. The conjugation mechanisms are discussed. (auth)

21230 RESULTS OF INVESTIGATIONS OF THE LOCAL AND INTEGRAL ELECTRON DENSITY IN THE IONOSPHERE BY MEANS OF COHERENT RADIO WAVES EMITTED BY A SATELLITE. II. Al'pert, Ya. L.; Vitshas, L. N.; Krayushkina, V. I.; Sinel'nikov, V. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 507-12(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 595-601(1971).

Some results of Elektron-1 and Elektron-3 observations at coherent radio frequencies of 20 and 30 MHz are reported. The data used include 284 observation sessions at Moscow, Sverdlovsk, Novosibirsk, Tbilisi. Some properties of the inhomogeneous cloud structure of the ionosphere are studied from the quasi-periodic variations of the difference in the Doppler shifts of coherent frequencies. Data are obtained on the distribution of the linear dimensions of inhomogeneities, the spectra of fluctuations of the reduced phase difference, electron density fluctuations, as well as on the time and height dependence of these quantities. (auth)

21231 ANGULAR INTENSITY DISTRIBUTIONS OF ENERGETIC CHARGED PARTICLES ABOVE THE ATMOSPHERE IN THE VICINITY OF THE COSMIC-RAY EQUATOR. Basilova, R. N.; Savenko, I. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 503-6(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 590-4(1971).

The intensity distributions of energetic particles with charges $Z \geq 1$ and $Z \geq 2$ by zenith and azimuth angles are presented. The measurements were made from the Proton-2 satellite at an altitude of ~450 km. The angular intensity distribution for particles with a charge $Z \geq 1$ differs from that for particles with a charge $Z \geq 2$. The difference in the angular distributions is discussed. (auth)

21232 EFFECT OF QUASI-PERIODIC IONOSPHERIC DISTURBANCES ON GEOMAGNETIC VARIATIONS. Yudovich, V. A. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 627-8(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 735(1971).

Previous experiments of effects of quasi-periodic ionospheric disturbances on geomagnetic variations are cited. Fluctuations with $T \sim 5$ to 15 min are attributed to gravity waves. From an analysis of data on traveling ionospheric disturbances it follows that this class of disturbances can be interpreted as the manifestation of internal gravity waves. A good correlation between ionospheric wave disturbances with a period of 2 to 5 min and strong storms in the troposphere has been found. An analysis of artificial disturbances in the atmosphere shows that phenomena taking place in the troposphere and stratosphere may be responsible for ionospheric disturbances up to the F region. The presence of quasi-periodic disturbances of considerable amplitude in the ionosphere suggests that they may affect the propagation through the ionosphere of electromagnetic waves recorded at the Earth's surface as geomagnetic variations. Solution of this problem for the real ionospheric plasma are very difficult, but qualitative characteristics of the disturbing effect are illustrated here, with assumptions leading to a solution for an infinite medium. It is assumed that the frequency of an electromagnetic wave is much higher than that of the conductivity disturbance and, disregarding displacement currents, an expression for the magnetic component of a linearly polarized, harmonic wave incident along the z axis is obtained from Maxwell equations. Estimates using the expression show that the modulation of electromagnetic signals of the SPP range by ionospheric disturbances can have marked effects. The brief increase or decrease of the amplitude of the SPP mode can be explained by the effect of large individual inhomogeneities. (J.C.W.)

21233 DURATION OF CONTINUOUS E, REFLECTIONS OF VARIOUS TYPES AT HIGH LATITUDES. Zherebtsov, G. A.; Kurilov, V. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 611-12(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 718-19(1971).

During the study of sporadic-E layers using the standard ionospheric data, possible errors are estimated. The dynamics of development of sporadic-E reflections, the alternation of one type of sporadic-E with another, and the change in the structural parameters of sporadic-E during auroras were investigated. Ionospheric soundings were performed on a continuous (1-min) schedule with an AIS in the winter and equinox of 1966–1967 at Noril'sk. Data from 100 h of continuous sounding in the presence of auroras both at the zenith and at the edges of the sky were analyzed. The sporadic-E curves show the limiting frequencies and types of layers during soundings at 1-min intervals. The duration of continuous reflection from sporadic E of one type is very small. It

was found that the more active the aurora, the shorter the duration of continuous reflections. The distribution of the duration of continuous sporadic-E reflections of given types is constructed and the distribution of continuous reflections during soundings at 15-min intervals is computed. (J.C.W.)

21234 DETERMINATION OF ABSORPTION IN THE LOWER IONOSPHERE FROM DATA ON THE SOLAR COSMIC-RAY FLUX DENSITY AND SPECTRUM. Driatskii, V. M.; Krupitskaya, T. M.; Shirochkov, A. V. (Arctic and Antarctic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 608-10(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 716-17(1971).

Theoretical absorption values are obtained for the lower ionosphere from data on the proton energy spectrum and compared with the experimental PCA riometer measurements. The calculations were made for Dixon and Vostok stations for July 7, 1966, and May 25, 1967, when PCA events were recorded by riometers at high latitudes. The expression is given for the proton energy spectrum from these PCA events. The rate of electron production by solar cosmic rays was calculated for various energy spectra and the electron density profiles $N_e(h)$ were obtained from the expression for the quasi-equilibrium state of the ionosphere. An unexplained fact is that the experimental and calculated data agree less well at low ($f < 30$ MHz) than at high frequencies. The proposed method for determining absorption from data on the solar cosmic-ray flux and spectrum makes is possible to estimate PCA intensity in reasonable agreement. (J.C.W.)

21235 HEIGHT AND FREQUENCY DEPENDENCE OF q_c AND PARTICLE TEMPERATURE IN THE DAYTIME F REGION IN SUMMER. Shapiro, B. S.; Potapova, N. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 606-8(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 713-15(1971).

It has been demonstrated previously that the variations in the quarter-thickness of the parabolic F2 and F1 ionization maxima of the daytime N(h) profile in summer reflect the temporal variations and the latitudinal distribution of electron temperature, T_e, and the differences in the temperatures of electrons and neutral particles, $T_e - T_n$, during a disturbance of the thermal equilibrium at the level of the density maximum, h_{max}. Results are given here of investigations of the height and frequency dependence of the quarter-thickness, q_c, and its possible relationship with the temperature of neutral particles and electrons. An analysis is made of the summer h_{max} and q_c values during high (1959–1960) and low (1964–1965) solar activity from the data available at the World Data Center B2, and the results of special computation of these parameter are tabulated. (J.C.W.)

21236 COMMON FEATURES IN THE VERTICAL DISTRIBUTION OF THE SEASONAL ANOMALY AND OF THE DISTURBANCE EFFECT IN THE DAYTIME TOPSIDE IONOSPHERE AT MIDDLE LATITUDES. Fatkullin, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 604-5(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 711-12(1971).

It is demonstrated that there are common features in the vertical distribution of a storm effect around noon at middle latitudes in the topside ionosphere and of the seasonal anomaly in electron density in topside F region. Alouette-1 data were used to analyze the noon hours in June and December 1963 under magnetically quiet conditions. It proved difficult to select $n_e(h)$ profiles for the summer and winter that would coincide exactly in coordinates and observation time. It follows that the n_e values in the topside ionosphere are higher in winter than in summer only at heights $\lesssim$500 km and there is no seasonal anomaly above. The height level above which a seasonal anomaly in the n_e of the topside ionosphere is observed apparently depends on latitude and the time of day, and may vary from day to day. Subsequent investigations have shown that the vertical extent of the seasonal anomaly in the topside ionosphere depends indeed on latitude and local time. The vertical distribution of the disturbance effect in the daytime, topside ionosphere at middle latitudes is also discussed. (J.C.W.)

21237 ESTIMATE OF THE DIFFUSION OF RESONANCE PROTONS FROM GROUND-BASED DATA ON Pcl. Kalisher, A. L.; Matveeva, E. T. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 631-3(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 739-40(1971).

There are three distinct stages in the dynamics of isolated Pc1 series; a rapid growth in signal amplitude, stabilization of amplitude, and its relatively slow attenuation. The second and third stages are nonlinear, and the third stage is controlled by the scattering mechanism of resonance particles on waves. The characteristic scattering times of resonance electrons on ulf waves have been estimated previously. A similar estimate is now performed for the scattering of energetic protons on Pc1 pulsations. The greatest indeterminacy in the pitch-angle diffusion coefficient arises because the amplitude of the pulsations in the region of effective interaction of the waves with the particles is not known. An attempt is made to show the relation between the Pc1 amplitude at the surface of the Earth associated with that in the magnetosphere. The Pc1 amplitudes were measured at Borok and Sogra in 1964–1965 at solar minimum, and separate measurements made for daytime and night. Differences are noted, but the difference decreases sharply if the hypothesis that Pc1 penetrate into the night hemisphere from the day hemisphere through the polar cap is applied. Estimates are made for the day hemisphere, and results show that Pc1 excitation results in the scattering of energetic outer-radiation-belt protons. (J.C.W.)

21238 EXCLUSION OF THE TEMPERATURE EFFECT OF THE MUON COMPONENT RECORDED UNDERGROUND. Sdobnov, V. E.; Luzov, A. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 600-3(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 707-8(1971).

A method is described of excluding the temperature effect on the intensity of μ-mesons recorded underground. The method selects such cosmic-ray components for which the densities of the temperature coefficients are similar. The system of equations are presented from previous data, but excluding the temperature effect in studying the variations of high-energy primary cosmic rays. The system of variational equations permits positive solution with respect to the spectrum of primary variations in the presence of four muon recording levels underground and particles with $E > 10$ GeV must be recorded at these levels. Some stations only have three recording levels, and so it is significant to determine the spectra of primary variations on the basis of the concept of effective energies. (J.C.W.)

21239 EVIDENCE OF DIRECTIONAL FILTERING OF TRAVELLING IONOSPHERIC DISTURBANCES. Yeh, K. C. (Univ. of Illinois, Urbana); Webb, H. D.; Cowling, D. H. Nature (London) Phys. Sci.; 235: No. 59, 131-2(14 Feb 1972).

It has been pointed out (J. Geophys. Res. 76: 213 (NSA 25: 11796)) that the strong thermospheric winds can act as a directional filter, and in a windy thermosphere an otherwise penetrating gravity wave may be reflected or asymptotically trapped near the lower thermosphere. Since both reflection and trapping occur below the ionospheric F2 peak, such waves may not excite travelling ionospheric disturbances of sufficient magnitude to be observable; hence, so far as the observation of travelling disturbances is concerned, the thermosphere would act like a directional filter, i.e., only those waves propagating in certain channels can reach ionospheric heights and excite travelling disturbances. In the northern hemisphere the thermospheric-wind locus rotates in a clockwise direction and, consequently, the allowed channel of propagation must also rotate in the same direction. Although experimental verification is difficult since continuous observations are required, no contradictory evidence has been reported. Muro's Australian data on travelling disturbances (Nature, 171: 69 (1953) and Austral. J. Phys. 11: 9 (1958)) are discussed in the present context. (UK)

21240 CORRELATION METHOD OF DETERMINING THE ELECTRON DENSITY IN THE IONOSPHERIC D REGION. Benediktov, E. A.; Grishkevich, L. V.; Ivanov, V. A.; Komrakov, G. P. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 9, 1452-4(1971). (In Russian).

The electron concentration in the D region of the ionosphere may be determined by partial reflection. A preliminary investigation was made of an experimental verification of a method for determining the electron concentration by the correlation coefficient between the amplitudes of an ordinary and an extraordinary wave. (K.S.W.)

21241 VARIATION OF IONOSPHERIC PARAMETERS AND STRATOSPHERIC CIRCULATION. Kazimirovskii, E. S.; Loginov, V. F.; Sukhomazova, G. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 620-1(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 727-9(1971).

The correlation between the meridional circulation of the stratosphere and the critical F2-layer frequencies, f_0F2, at local noon at 80 to 90 stations of the global network for Mar., June, Sept., and Dec. 1958 is examined. Deviations were found

of critical frequencies, Δf_0F2, from the average monthly global distribution of the noon f_0F2 values. The two factors thought to be responsible for the deviations are: the geomagnetic effect and hydrodynamic interactions with the underlying atmospheric layers through gravity waves. The results obtained are explained by a change in the conditions of the upward leakage of the energy of pressure disturbances and a change in the intensity of meridional circulation in the lower atmosphere, which may be the cause of fluctuations in ionospheric parameters. The correlation is closest during the development of meridional processes in the stratosphere and during the restructuring of circulation from the winter to the summer type. (J.C.W.)

21242 COMPARISON OF SIMULTANEOUS SATELLITE MEASUREMENTS OF AURORAL PARTICLE PRECIPITATION WITH BOTTOMSIDE IONOSONDE MEASUREMENTS OF THE ELECTRON DENSITY IN THE F-REGION. Turunen, T.; Liszka, L. (Kiruna Geophysical Observatory, Sweden). J. Atmos. Terrest. Phys.; 34: No. 3, 365-72(Mar 1972).

Satellite measurements of auroral-particle precipitation made on board the polar orbiting ESRO-1A for six satellite orbits are compared with simultaneous bottomside ionosonde measurements from the Scandinavian network. It is found that, in the cases investigated, the boundaries of the precipitation zone and the polar plasma torus and the trough are very well tied together. (auth)

21243 CUSP ACTIVITY NEAR THE E-REGION CRITICAL FREQUENCY. Jones, T. B.; Hart, J. W. S. (Univ. of Leicester, Eng.). J. Atmos. Terrest. Phys.; 34: No. 3, 387-400(Mar 1972).

Experimental observations during the period 1966 to 1969 indicated the presence of multiple cusp structure near f_0E and attempts were made to find compatible models of the electron-density distribution in the height range 110 to 170 km. Three sets of N(h) profiles from independent sources were used to compute, by means of the phase integral analysis, the variation of virtual height with frequency. By comparison with experimental observations for approximately the same time, it is shown that monotonic profiles obtained by the Titheridge polynomial reduction method and profiles observed by the Thomson-scatter technique well represent the conditions giving rise to multiple cusp structure. It is suggested that such structure results from small redistributions in electron density at and above the E-region maximum. (auth)

21244 CLASSIFICATION OF NIGHT-TIME ELECTRON-DENSITY PROFILES. Knight, P. (British Broadcasting Corp., Surrey, Eng.). J. Atmos. Terrest. Phys.; 34: No. 3, 401-10(Mar 1972).

Published measurements of the electron density of the night-time ionosphere were arranged according to the times after sunset at which they were made; other measurements made during the sunrise period were arranged with respect to solar zenith angle. A set of idealized electron-density profiles for the night-time and sunrise periods is derived from these measurements. (auth)

21245 OBSERVATIONS OF AURORAL-ZONE X-RAYS WITH ENERGIES UP TO AND GREATER THAN 200 keV. Jentsch, V.; Kremser, G. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). J. Atmos. Terrest. Phys.; 34: No. 3, 499-511 (Mar 1972).

Balloon measurements of auroral-zone x rays revealed several precipitation events of electrons with energies up to some hundred keV. These events can be divided in two groups according to their energy spectrum. Events with relatively steep energy spectrum occur during the daytime. Their spectrum can be approximated in an exponential form with characteristic energies well below 50 keV. Nighttime events have a flat energy spectrum, which deviates from an exponential form. In these cases the calculated characteristic energies of exponential fittings over limited energy intervals were generally above 50 keV and a considerable variability of the spectrum was observed. Maximum values of the characteristic energy are often related to maximum changes of intensity, not to maximum intensities. These nighttime events are not related in a unique way to a certain phase of the polar substorm. (auth)

21246 IN SITU OBSERVATIONS OF ENHANCEMENTS IN THE F-REGION ELECTRON DENSITY ASSOCIATED WITH THE OCCURRENCE OF A SPORADIC-F TRACE ON THE IONOGRAM. Maehlum, B. N. (Norwegian Defence Research Establishment, Kjeller). J. Atmos. Terrest. Phys.; 34: No. 3, 513-16(Mar 1972).

Rocket observations of the auroral F-region and precipitated, low-energy electrons during a period of sporadic F are discussed. It is shown that the origin of the sporadic-F trace is a significant enhancement in the F-layer ionization, produced by low-energy precipitated electrons accompanied by enhanced red O I (λ6300 A) emission. (auth)

21247 INFLUENCE OF NEUTRAL WINDS ON THE NO^+ AND O_2^+ DENSITIES IN THE LOWER IONOSPHERE AT NIGHT. Stubbe, P. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). J. Atmos. Terrest. Phys.; 34: No. 3, 519-23(Mar 1972).

Direct measurements of the nighttime ion and electron densities between 120 and 230 km by Holmes et al. (1964) show a deep and broad valley in the NO^+ and electron distributions located around 170 km. Several authors attempted to describe this situation in terms of chemical equilibrium by assuming different values for the reaction rates, however with little success. Walker and McElroy (J. Geophys. Res., 71: 3779(1966)) suggested that the neglect of particle transport could be the reason for the disagreement between theory and experiment. It is shown that the valley in the nighttime ionosphere can be explained by the action of the neutral-wind system that follows from the present atmospheric models. (auth)

21248 SECONDARY ELECTRON EXCITATION IN THE AURORA. Gerard, J. C. (Univ., Liege). J. Atom. Terrest. Phys.; 34: No. 3, 531-5(Mar 1972).

A calculation of emission rates of a few important auroral features is made, based on recent cross-section data and measured secondary electron spectra. A comparison of values obtained with observations shows a satisfactory agreement for most emissions. However, it appears that direct impact of secondary electrons on oxygen atoms ($^3P-{}^1S$ transition) contributes to about 10% of the green-line intensity. The same percentage is reached for secondary ionization of N_2 ($X^1\Sigma_g-B^2\Sigma_u^+$ transition) giving rise to the first negative bands. (auth)

21249 D-REGION EXTRAIONIZATION AND SOLAR X-RAY FLUX DERIVED FROM SPA AND SES MEASUREMENTS. Barletti, R.; Tagliaferri, G. L. (Osservatorio di Arcetri, Florence). J. Atmos. Terrest. Phys.; 34: No. 3, 543-7(Mar 1972).

Some assumptions used in deriving solar fluxes from vlf data are discussed; attention is drawn to the shape of the solar spectrum and to the continuity equation. A few results concerning the simplest model of a solar burst are also presented. Solar fluxes derived from vlf data are compared with the SOLRAD-8 measurements. (auth)

21250 RADIO AND SPACE RESEARCH 1968–1970. Report of the Director of the Radio and Space Research Station. Saxton, J. A. London; Her Majesty's Stationery Office (1971). 63p. 80 pence. (NP–19177).

This report of the work carried out during the years 1968–1970 by the Radio and Space Research Station includes sections in NSA scope covering; the upper ionosphere (top-side sounding, the effect of neutral winds and electric fields in the F region, fading of vhf and uhf signals from geostationary satellites, incoherent ionospheric scatter, theoretical studies of the magnetosphere, investigation of the field strength produced by a distant hf transmitter, study of ionograms obtained at oblique incidence, application of data from Earth satellites to F-region mapping, improvements in ionospheric predictions for hf communications, and effects of directional fluctuations on the gain of large aerials at high frequencies), measurement of energetic particles (rocket-borne particle experiments and ESRO 1 satellite experiments), solar physics and related phenomena in interplanetary space (solar radio emission and scintillation of radio waves in the interplanetary medium). (UK)

21251 NIGHTTIME CHANGES OF THE IONOSPHERE DURING GEOMAGNETIC STORMS. Katz, A. H. (Avco System Div., Wilmington, Mass.); Papagiannis, M. D. J. Atmos. Terrest. Phys.; 34: No. 3, 525-30(Mar 1972).

Electron-density profiles below the maximum of the ionosphere were computed for quiet and disturbed conditions during three geomagnetic storms. The profiles were computed for several stations of different latitude along the 75°W meridian and were compared at specific nighttime hours when significant changes in height make necessary the investigation of the entire profile rather than N_{max} alone. This analysis showed that, at higher geomagnetic latitudes, the storm-time values of h_{max} and N_{max} are considerably higher than the quiet values in the pre-midnight period. In the post-midnight period, h_{max} is still much larger while N_{max} falls below the quiet values. The transition to this pattern seems to occur around 30 to 40°N geomagnetic latitude moving possibly to lower latitudes for the more intense storms. For the low-latitude stations, a well defined, repetitive pattern of storm-time changes for the three storms analyzed could not be detected. (auth)

21252 MORPHOLOGY OF DISPLAYS OF PULSATING AURORAS. Cresswell, G. R. (Geophysical Inst., College, Alaska). J. Atmos. Terrest. Phys.; 34: No. 3, 549-54(Mar 1972).

An auroral substorm generates displays of pulsating auroras in ways that show a dependence upon both local time and latitude relative to the auroral oval. For several hours after midnight, pulsating auroras can be observed in the wake of poleward expansions or within equatorward spreading diffuse envelopes of meridional extent several hundred kilometers. As the dawn meridian is approached, the displays of pulsating auroras tend increasingly to be comprised of distinct eastward-drifting patches easily recorded by all-sky cameras. (auth)

21253 EVIDENCE OF A PREFERENTIAL EXCITATION OF N_2^+(λ 3914A) IN AN AURORA. Vreux, J. M. Bull. Cl. Sci., Acad. Roy. Belg.; 57: No. 6, 655-68(1971). (In French).

Intensities of 5577-A[O I] and 3914-A(N_2^+) emissions were recorded during two rocket flights. A selection of the measurements effected with the photometers axes parallel to a horizontal plane showed a systematic variation of the ratio $R(h) = I_{5577}(h)/I_{3914}(h)$. The ratio shows a minimum at the altitude of maximum ionization. The result is compared with recent observations of ultraviolet emissions. (France)

Particle Kinetics and Trapping

Refer also to abstracts 21237, 21265, and 21967.

21254 FLUCTUATING MAGNETIC FIELDS IN THE MAGNETOSPHERE. 1. ELF AND VLF FLUCTUATIONS. Russell, C. T.; McPherron, R. L.; Coleman, P. J. Jr. (Univ. of California, Los Angeles). Space Sci. Rev.; 12: No. 6, 810-56(Jan 1972).

The study of extremely-low-frequency (elf) and very-low-frequency (vlf) waves in space has been intensively pursued in the past decade. Search-coil magnetometers, magnetic loop antennas, and electric-dipole antennas have been carried on board many spacecraft. The measurements performed by these instruments have revealed a multitude of wave phenomena, whose study in turn is providing a wealth of information on the physics of the magnetospheric and ionospheric plasma. Two classes of wave phenomena are observed: whistlers and emissions. The observed whistler phenomena include: multiple-hop ducted whistlers, ion-cutoff whistlers, ion-cyclotron whistlers, subprotonospheric whistlers, magnetospherically reflected whistlers, and walking-trace whistlers. The emissions observed at high altitudes near the magnetic equator differ in many respects from those observed at low altitudes near the ionosphere. At high altitudes, inside the plasmasphere, elf hiss is the dominant emission and, outside the plasmasphere, chorus is the dominant emission. Also seen is a sub-LHR hiss band in the outer plasmasphere near the equator, and high-pass noise and broadband noise in the outer nightside magnetosphere. At low altitude, both elf hiss and chorus are present but, here, elf hiss is the dominant emission even outside the plasmasphere. Additional emissions, specific to low altitudes, such as vlf hiss and LHR noise are also observed. Although the observations of these phenomena by spacecraft have been complemented by many ground-based and rocket-borne studies as well as by spacecraft observations of man-made signals, reviews are made of only satellite observations of signals of natural origin. (110 references) (auth)

21255 CHANGES OF PLASMASPHERE SIZE AS INFERRED FROM K AND K_p INDICES ALONE. Krainski, Waldemar (Inst. of Geophysics, Warsaw). Acta Geophys. Pol.; 19: No. 3, 305-11(1971).

It is assumed that origins of the disturbances determining K indices are on the night side of the plasmapause and the diminution of average disturbance amplitude—going from Φ_M corresponding to the plasmapause, toward lower, but yet sufficiently great, latitudes—depends only on $\Phi - \Phi_M$, independently of actual Φ_M. With these assumptions, the relation between the plasmasphere size (defined by the latitude Φ_M) and K_p, on the basis of only K_p indices and K indices from Racibórz, is derived. The form of this relation is: $\Phi_M = 76° - 4°K_p$. According to the way on which it was obtained, the relation does not concern actual values of Φ_M and K_p, but rather the level of geomagnetic activity fixed for a longer time. The relation obtained was then compared with the relation given by Binsack. The disagreements among them for middle and low values of K_p indices may be explained by the assumption of a long reconstruction time (some days) for the plasmasphere. (auth)

21256 HIGH-LATITUDE GEOMAGNETIC-FIELD PULSATIONS AND THEIR USE IN THE IDENTIFICATION OF MAGNETOSPHERIC PARAMETERS. Raspopov, O. M.; Chernous, S. A.; Kiselev, B. V. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 567-70(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 669-73(1971).

Geophysical data obtained during negative high-latitude geomagnetic disturbances are analyzed. A new type of geomagnetic pulsation, generated during the development of high-latitude disturbances, is found. The amplitude of these pulsations reaches a maximum when auroral arcs cross the zenith at Heiss Island. The time of their generation lags behind that of Pi2 at southern stations. (auth)

21257 PULSATIONS OF DECREASING PERIOD AS A PROTON-BEAM INSTABILITY. Feygin, F. Z.; Yakimenko, V. L. (Inst. of Terrestrial Physics, Moscow. Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 564-6(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 665-8(1971).

The cyclotron instability of proton beams having a directional velocity from several to tens of keV is analyzed. It is demonstrated that R and L waves can be excited during the deceleration of such a proton beam. Excitation of Pc1 pulsations is possible at beam velocities that are much lower than the rates of thermal scatter of particles in the beam. Deceleration of the beam leads to the excitation of a broad spectrum of R waves with increasing frequency, which can probably be identified with phenomena of the type of pulsations of decreasing period. (auth)

21258 PHYSICS OF THE 11-YEAR VARIATION OF MAGNETIC DISTURBANCES. Ol, A. I. (Arctic and Antarctic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 549-51(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 647-50(1971).

The relationship between unipolar magnetic regions on the Sun and magnetic disturbance is investigated. It is demonstrated that recurrent magnetic disturbances are associated with the "ghosts" of unipolar regions. On the basis of a study of the variations of magnetic disturbance in the 11-year solar activity cycle it is concluded that this cycle has two phases; unipolar magnetic regions develop during the first phase and bipolar regions during the second. (auth)

21259 EXCITATION OF ION-ACOUSTIC WAVES IN THE MAGNETOSPHERE. Chmyrev, V. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 545-8(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 643-6(1971).

It is demonstrated that ion sound can be excited during the propagation of hydromagnetic waves through regions of the magnetosphere where the plasma density varies rapidly. The transformation coefficient of fast magneto-acoustic waves into ion-acoustic waves is calculated for the transition layer (plasmapause). (auth)

21260 SIMULATION OF THE PENETRATION OF FAST PARTICLES THROUGH THE NEUTRAL POINTS OF THE MAGNETOSPHERE. Dubinin, E. M.; Managadze, G. G.; Podgornyi, I. M. (Inst. of Space Research, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 625-6(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 733-4(1971).

Model experiments make it possible to investigate processes inside the magnetosphere and to study the penetration of fast charged particles through the magnetosphere boundary. The penetration of these solar-wind-originated charged particles can explain several auroral phenomena in the magnetosphere. As a source for the artificial solar wind, a plasma accelerator was operated in such a mode that, in the hydrogen plasma flux, there was a small group of electrons with energies of ~8 keV. The interaction of these electrons with the artificial magnetosphere was investigated. Results show that the penetration of fast particles into an artificial magnetosphere occurs at 10 to 20° latitude and is probably produced by the instability of the magnetosphere boundary in the vicinity of neutral points. Whether injection in the vicinity of neutral points is the main reason for the appearance of fast particles in the magnetosphere is not absolutely known, but fast particles effectively injected in these areas must play an important role in the dynamics of particles in the magnetosphere. (J.C.W.)

21261 MAGNETIC FIELD OF VERTICAL CURRENTS IN THE MAGNETOSPHERE. Rudneva, N. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 623-5(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 731-2(1971).

Results of computations of the magnetic-field components of current systems I and II at the boundary of the magnetosphere (L = 10) and at the surface of the Earth (L = 1) are reported. The magnetic-field components of system I were computed in-

side the magnetosphere at L = 3. The computations were performed on a computer from the formulas by the approximate Gaussian method. The distance to the magnetosphere boundary depends on geographic longitude, suggesting that vertical currents exist in the magnetosphere whose density depends on this longitude. The longitudinal difference between vertical currents is described by current system I or II. In system I the currents flow from the equator toward the poles at geographic longitudes φ = 10 to 210° and from the poles to the equator at φ = 210 to 10°, occupying the volume between the shells L = 4 and 8 and the cones θ = 34 and 146° (θ is the polar angle reckoned from the North Pole). In addition to currents in the outer magnetosphere, system II includes currents within the magnetosphere between the shells L = 1.5 and 4 and the cones θ = 24° and 156°. The direction of the currents is opposite in the inner and outer magnetosphere. (J.C.W.)

21262 RELATIONSHIP BETWEEN SOME OUTER RADIATION BELT PARAMETERS AND INTERPLANETARY SPACE. Kuznetsov, S. N.; Stolpovskii, V. G. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 596-7(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 703-4(1971).

A general relationship between the radiation-belt characteristics and various parameters of interplanetary space are analyzed, including various parameters of the outer radiation belt, the sector structure of the interplanetary magnetic field, and solar-wind velocity. The sign of the sector of the interplanetary field was determined from data in a paper by Coon. As a characteristic of the outer radiation belt, the position of the belt boundary from Elektron-4 data and the intensity of electrons with $E_e \geq 150$ keV at L = 5 and 6 was used. The belt boundary was determined from the characteristic break on the electron intensity profile data in NSA 22: 34443. It is shown that for all values of UT the belt boundary is located closer to the Earth in the positive than in the negative sector at $\Delta L \approx 2$ to 3. The position of the belt boundary has a well defined diurnal pattern as a function of UT, for both the positive and negative sectors. (J.C.W.)

21263 INTERNAL SOURCE OF THE DIURNAL MAGNETIC ACTIVITY PATTERN. Shneyer, V. S. (Arctic and Antarctic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 628-30(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 736-8(1971).

Magnetic-activity variations at the Earth's surface are known to be produced by quasi-periodic and sporadic processes in the Earth's magnetosphere and ionosphere. The diurnal pattern of magnetic activity is associated with the daily rotation of the Earth under the ionospheric current system that is motionless with respect to the direction toward the Sun. Recent studies have shown that the contribution of the internal part of the Earth's magnetic field, formerly disregarded, is significant to the diurnal magnetic activity pattern and very variable in space. Previously, it had been considered constant in space and time. To substantiate the findings, data from simultaneous recordings in July–August 1958 of magnetic variations made at Tikhaya and Heiss (Franz Joseph Land), which are 10 km apart on the same geomagnetic parallel, are analyzed. Assuming the height of the source of variations to be ~100 km, it was to be expected that the magnetic variations at both observatories would be completely identical; but there were significant differences, attributable to the geologic characteristics of the region. As a measure of magnetic activity the hourly ranks taken on 20 of the stormiest days of July and August are used; and from these data, the average diurnal patterns are constructed and their differences are obtained for the two stations. (J.C.W.)

21264 EQUATORIAL MICROSTRUCTURE OF THE MAGNETIC STORM OF 13–14 JANUARY 1967. Roquet, J. (Institut de Physique du Globe, Paris); Gouin, P. J. Atmos. Terrest. Phys.; 34: No. 3, 465-74(Mar 1972).

A study was made of Pc1 recorded simultaneously at the equatorial station of Addis Ababa, Ethiopia, and the middle latitude stations of Chambon-la-Forêt and Garchy, France, during the world-wide magnetic storm of January 13 to 14, 1967. The macrostructure of the storm is briefly described. Sonagram analyses from Chambon-la-Forêt show that these Pc1 were unstructured at middle latitudes. The Pc1 amplitudes were greater at the equator than at middle latitudes, when normally the amplitude of Pc1 (the pearl-type was more extensively studied) decreases with decreasing latitude. Only one other similar case was observed in Africa, that of February 28 to 29, 1968. Possible correlations between the present magnetic-field observations and satellite data available in the literature were investigated. The observed characteristics of the Pc1 on January 14, 1967 were also compared with such analogous phenomena as "continuous sub-ELF emissions," micropulsations during substorms, IPDP, "sweepers," and "gurglers." Hypotheses concerning the origin of these phenomena are reviewed. (auth)

Solar Wind and Cosmic Ray Interactions

Refer also to abstracts 21059–21061, and 21249.

21265 RELATIONSHIP BETWEEN THE VARIATIONS OF THE VELOCITY AND MAGNETIC FIELD IN THE SOLAR WIND AND VARIATIONS OF THE K_p INDEX. Mikerina, N. V.; Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 621-3(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 729-30(1971).

The maxima of the temporal variations of the average diurnal solar-wind flux velocity, v, usually correspond to the maxima of the diurnal sums of the magnetic activity index, ΣK_p. More detailed characteristics of 3-hour averages or magnetograms reveal a tendency for magnetospheric storms to appear at the stage of increasing velocity. The appearance of a storm at the increasing stage of v until v_{max} is reached shows the important role played by the flux instability in the development of magnetospheric storms and also that v is not the direct, main reason for the disturbances. A step forward here in the search for geophysically effective physical characteristics of the solar wind compared with the use of v alone or F, interplanetary magnetic field, alone, is the introduction of the quantity E_φ; the electric field of the solar wind is easterly (in a coordinate system that is motionless with respect to the Earth) $E_\varphi = -[vF]$, i.e., $E_\varphi = vF_S$, where F_S is the southern interplanetary magnetic field. (J.C.W.)

21266 SOLAR-PARTICLE SPECTRUM IN THE INITIAL PERIOD OF THE FLARE OF FEBRUARY 23, 1956. Miroshnichenko, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 598-600(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 705-6(1971).

The spectra of solar cosmic rays differ at the instant they are ejected from the flare region and the instant they are measured near the orbit of the Earth. The observed spectrum is dependent on such processes as protracted acceleration and emission or propagation of the particles. A comparison is made of the spectra of particles from the Feb. 23, 1956 flare for several instants. The difference between the spectra examined is probably better explained by the anisotropic propagation of solar particles in the presence of magnetic inhomogeneities that scatter the particles at small angles rather than by protracted ejection. The conclusion refers only to particles with R > 1 GV and is valid for the initial stage of a flare (before the occurrence of the intensity maximum at the orbit of the Earth). (J.C.W.)

21267 THREE-DIMENSIONAL COSMIC RAY ANISOTROPY IN INTERPLANETARY SPACE. PART I. FORMULATION OF COSMIC RAY DAILY VARIATION PRODUCED BY AXIS-SYMMETRIC ANISOTROPY. Nagashima, Kazuo (Nagoya Univ., Japan). Rep. Ionosphere Space Res. Jap.; 25: No. 3, 189-211 (Sep 1971).

An analytical method to determine three-dimensional cosmic-ray anisotropy in interplanetary space from the observation of cosmic-ray variation is undertaken and the method is applied for determining the origin of the cosmic-ray semidiurnal variation. In general, observation of the single harmonic component of daily variation gives only limited information about a projected component of anisotropy in the equatorial plane and cannot determine the anisotropy in space, much less the origin of the anisotropy. For example, observation of semidiurnal variation cannot determine whether the variation is due to the cosmic-ray density gradient in space or due to the cosmic-ray pitch-angle distribution against interplanetary magnetic line of force, because both anisotropies due to these hypotheses produce similar semidiurnal variations, in spite of their different forms of space distribution. In order to determine the origin, it is required to observe a "special" diurnal variation characterizing these anisotropies. Different from the "usual" diurnal variation, the present variation exhibits strange behavior in that its yearly average becomes very small or zero as a result of its annual modulation due to the Earth's revolution around the Sun in spite of finite daily amplitude. Because of this nature, it is necessary to observe the annual modulation of the "special" diurnal variation for the determination of the origin. In order to perform such an extensive analysis,

which utilizes effectively all the related harmonic components of daily variation, the daily variation arising from a generalized anisotropy in space is formulated here. The results give decisive evidence that supports the pitch-angle-distribution hypothesis. (TSS) (auth)

21268 THREE-DIMENSIONAL COSMIC RAY ANISOTROPY IN INTERPLANETARY SPACE. PART II. GENERAL EXPRESSION OF ANNUAL MODULATION OF DAILY VARIATION BY FREQUENCY MODULATION METHOD AND ITS APPLICATION TO THE MODULATION DUE TO EARTH'S REVOLUTION AROUND SUN. Nagashima, Kazuo; Ueno, Hirosachi (Nagoya Univ., Japan). Rep. Ionosphere Space Res. Jap.; 25: No. 3, 212-41(Sep 1971).

An analytical method to determine the three-dimensional cosmic-ray anisotropy in interplanetary space from observation of the cosmic ray daily variation is undertaken and the method is applied for determining the origin of cosmic ray semi-diurnal variation. As a basis of such an extensive analysis, which utilizes effectively all the related harmonic components of daily variation, the daily variation arising from a generalized anisotropy in space was formulated theoretically in Part I. Based on the formulation, a general expression for the annual modulation of the daily variation is obtained here by utilizing the frequency-modulation method and applied to the modulation due to the Earth's revolution. If the m-th harmonic component of daily variation, its frequency being equivalent to (mf_0 = 365m) cycle/year, is subjected to annual modulation with a frequency of f cycle/year, new variations are produced with side frequencies of ($mf_0 \pm f$) in addition to the original. These variations can be expressed respectively by vectors on the m-th harmonic dials of the extended sidereal and anti-sidereal time, their hourly units being defined by $\{24(f_0 \pm f/m)\}^{-1}$ year. Conversely, the annual modulation can be easily reproduced by composing these vectors on the solar m-th harmonic dial. Based on the formalism of the daily variation and its annual modulation, the extensive analyses to determine the origin of anisotropy responsible for the solar semidiurnal variation will be performed in Parts III and IV (to appear later) by using the ion-chamber data at Cheltenham and Christchurch as well as the data of multi-directional large area cosmic-ray telescope at Mt. Norikura. (TSS) (auth)

21269 SOLAR SEMIDIURNAL ANISOTROPY OF COSMIC RADIATION. Fujii, Zenjiro (Nagoya Univ., Japan). Rep. Ionosphere Space Res. Jap.; 25: No. 3, 242-70(Sep 1971).

The average feature of the cosmic-ray semidiurnal anisotropy is studied with data obtained by a new cosmic-ray telescope at Mt. Norikura, which records the intensities from five different directions with a high counting rate of about 10^6/h. Analysis is made using differences between two components in order to eliminate atmospheric effects and worldwise isotropic variations. It is found that the average semidiurnal anisotropy has the rigidity spectrum with maximum intensity of about 0.2% at around 70 GV, and the average direction of the anisotropy is 3.5 ± 0.3 and 15.5 ± 0.3 h LT. In order to explain the observed semidiurnal anisotropy, the existence of loss cone in the cosmic-ray pitch-angle distribution is assumed along the interplanetary magnetic field towards the Sun, i.e., 9 h LT. A quantitative examination by spherical harmonics shows that this model produces a $\sin^2 \chi$-type pitch-angle distribution of cosmic rays as one component, which is in agreement with the observed semidiurnal anisotropy. The loss-cone model suggests the existence of harmonic components of infinite series of order in the cosmic-ray daily variation. Each of these components has a particular latitudinal distribution and a specific change of its amplitude during a year. The directions and the relative amplitudes of these components depend on the angle of the loss cone. (TSS) (auth)

21270 ANALYSIS OF THE SOLAR SEMIDIURNAL VARIATION OF COSMIC RADIATION. Mori, Satoru; Yasue, Shin-ichi; Ichinose, Masaoki (Shinshu Univ., Matsumoto, Japan). Rep. Ionosphere Space Res. Jap.; 25: No. 3, 271-84(Sep 1971).

An anisotropy in space responsible for the observed solar semidiurnal variation of the cosmic radiation was investigated by using the data from the worldwide neutron monitor stations. Chi-square test for the best fit between the observed and the expected variation confirmed the existence of a consistent anisotropy in space having the direction of around 3 hr LT. The statistical test also revealed the spectral dependence of this anisotropy. On the assumption of the power-exponential-type rigidity spectrum in a shape of $R^\gamma \exp(-R/R_0)$, and the declination distribution of a form of $\sqrt{3}/2 \cos^2 \lambda$, it is found that in the best-fit spectrum, the rigidity γR_0 giving a peak intensity is about 50 GV. This relation holds for the positive γ of +1.0 to +2.5 and in the 70 to 15 GV range of R_0, thus the parameters for the spectrum of the anisotropy would not be defined uniquely. The present result is in good agreement with Nagoya's $\gamma R_0 \sim 70$ GV, derived from the data of the multidirectional meson telescope. It seems that the constancy of the product γR_0 may result in effective modulating rigidity that will produce the observed solar semidiurnal variation. (auth)

21271 CHARACTERISTICS OF THE ENERGETIC SOLAR X-RAY BURST OF FEBRUARY 11, 1970 OBSERVED AT BALLOON ALTITUDE. Kodama, Masahiro (Inst. of Physical and Chemical Research, Tokyo); Kusunose, Masahiko; Ogura, Koichi. Rep. Ionosphere Space Res. Jap.; 25: No. 3, 285-300 (Sep 1971).

On February 11, 1970, a balloon-borne NaI scintillation detector launched from Syowa Station in Antarctica recorded about a 28-fold intensity enhancement per second of energetic solar x-rays above 22 keV at a height of 7 g/cm^2 during a solar flare of class 2B started at 0704 UT. This is the largest x-ray burst observed so far at balloon altitudes. The hard solar x-ray burst commenced at about 0706 UT, when the solar microwave burst started, and lasted for nearly 7 minutes. As a whole, the time–intensity profile of both the x-ray and microwave bursts was quite simple and showed two distinct peaks at 0706:48 and 0708:40 UT, which were characterized by different x-ray energy spectra corresponding to the different radiofrequency spectra. The time of the double x-ray peaks was fixed definitely in the energy range from 22 to 176 keV and was closest to that of 35-GHz radio burst. However, the time delay of the microwave peaks, except 35 GHz, from the x-ray peaks was found to increase with decreasing radiofrequency, amounting to about 2 minutes in the case of a 1-GHz radio burst. A brief comparison of the balloon data with the observation results from OSO-5 satellite indicates a close similarity for the quasi-periodic variation found with a period of about 6 sec, as well as for the whole development. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 21661 and 22060.

21272 (FRNC-TH-134) USE OF AN H-F SOURCE FOR PRODUCING HEAVY IONS, APPLICATION TO THE CHLORINE SPECTRUM. Subtil, Jean-Louis (Lyon Univ. (France)). 1971. 70p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A particularly simple heavy ion source was developed. It consists of a classical hf source with a lateral input for metallic vapor compounds. Ferric chloride vapor was used to produce Fe^+ and Cl^+ ions. Various types of heavy ion source are described, together with the test bench used. The variations in the mass spectra of the ions extracted were studied as a function of the temperature of the $FeCl_3$ evaporation furnace and the effect of the different parameters controlling the flow. The source, which is very useful for producing Cl^+, was used to study the spectra of atomic chlorine excited by collisions in a gaseous target. (France)

21273 (IPPJ-109) BACK-DIFFUSION TYPE SOURCE OF MONOENERGETIC IONS. Honzawa, Tadao (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jul 1971. 15p. NTIS (U. S. Sales Only).

A new type of ion source that can be operated in any kind of gas at a pressure from 10^{-6} to 10^{-2} torr is described. The source can produce monoenergetic ions with a controllable energy from a few tens to several hundreds eV and with density up to several times 10^7 cm^{-3}. (auth) (Japan)

21274 (SC-T-713088) SCATTERING OF Cs ATOMS BY A Ta SURFACE. Arifov, V. A.; Flyants, N. N.; Khadzhimukhamedov, Kh. Kh. Translated for Sandia Labs., Albuquerque, N. Mex., from Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; 12: No. 5, 69-72(1968). 7p. Dep. NTIS.

The scattering of Cs atoms by a Ta surface was studied by a method in which a current of neutral Cs atoms obtained by bombarding a first Ta target (M1) by Cs ions was caused to be normally incident on a second Ta target (M2). The current intensity of tertiary positive ions was measured as a function of the temperature of M2. Overall scattering coefficients were calculated. (A.G.W.)

21275 EFFECT OF THE PRIMARY-ELECTRON INCIDENCE ANGLE ON THE SECONDARY EMISSION OF PYROLYTIC GRAPHITE AND CONDENSED CARBON FILMS. Kazantsev, A. P.; Matskevich, T. L. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 4, 708-10(Apr 1971).

Translated from Radiotekh. Elektron.; 16: No. 4, 645-7(Apr 1971).

An investigation was made of the angular dependence of the secondary emission coefficient δ of unsupported C films. The dependence of δ and η on φ and U_p was measured for U_p = 5 to 20 keV and φ = 0 to 80° for bulk pyrolytic graphite and unsupported C films 300 to 3000 Å thick. For pyrolytic graphite, $\delta_\varphi/\delta_0 = 2.7 \pm 0.1$ was independent of U_p, while for the films it decreased with U_p, approaching 2.15 ± 0.15. The effect of the inelastically reflected electrons was evaluated, using a δ_{ee}/δ_t vs η_{ee} plot. The applicability of the theory of Nakhodkin et al. (Fiz. Tverd. Tela, 4: 1514 (1962)) was examined. The effects of fast secondary electrons were considered. (D.L.C.)

21276 SECONDARY ELECTRON EMISSION FROM SOLID SURFACES BOMBARDED BY MEDIUM ENERGY IONS. Cawthron, E. R. (Australian National Univ., Canberra). Aust. J. Phys.; 24: No. 6, 859-69(Dec 1971).

The results of Cawthron, Cotterell, and Oliphant for the emission of electrons produced by bombardment of a metal surface with various kinds of positive ions are compared with the predictions of proposed theories. It is seen that the complexity of the interaction processes occurring when a positive ion enters a surface is such that the emission process can only be described in a non-analytical manner, using a statistical treatment. The following discussion indicates that the observed results can be predicted qualitatively over a reasonable range of bombarding energies for many targets and ions by applying the theory of Parilis and Kishinevski. The energy-loss cross sections, as well as the actual ionization cross sections, are shown to be important factors in determining the total emission. (auth) (Australia)

21277 PERFORMANCE OF THE TWIN WIRE ELECTROSTATIC CHARGED PARTICLE OSCILLATOR. Rushton, G. J.; Fitch, R. K. (Univ. of Aston, Birmingham, Eng.). Vacuum; 21: No. 10, 449-52(Oct 1971).

Experiments are described which show how the performance of the twin wire electrostatic charged particle oscillator is affected by such parameters as the anode diameter, anode separation and the presence of stray magnetic fields. The performance of this oscillator when used as an ion source is discussed. (auth) (UK)

21278 STUDY AND MEASUREMENT OF THE CHARACTERISTICS AND POLARIZATION OF A POLARIZED ATOMIC JET. Gilles, J. P.; Coiffet, Ph.; Brebec, J. M. (Univ. Paris, Orsay, France). Nucl. Instrum. Methods; 99: No. 1, 49-61(1972). (In French).

A polarized potassium atom source is studied. The atomic beam effuses from a multichannel nozzle and crosses the inhomogeneous field of a sixpole magnet. Determination of the beam properties takes place at various distances from the end of the magnetic lens. Polarization measurements of the atomic beam are made by using an improved Rabi technique. Polarization variations as functions of temperature and position along a beam diameter are studied. A mean polarization of 90% ± 2% is obtained at the output of the hexapole magnet. (13 figures, 5 tables) (auth)

Atomic and Molecular Properties

Refer also to abstract 21338.

21279 (SC-RR-710507) ANALYTICAL APPROXIMATIONS FOR X-RAY CROSS SECTIONS. [PART] II. Biggs, Frank; Lighthill, Ruth (Sandia Labs., Albuquerque, N. Mex.). Dec 1971. 143p. Dep. NTIS.

Analytical approximations efficient for use in computer programs are given for the photoelectric, incoherent-scattering, and energy-transfer cross sections for photons of energy greater than 0.01 keV. All the atoms of atomic numbers $1 \leq Z \leq 100$ are included. The photoelectric cross section is approximated by four-term polynomials in reciprocal powers of the photon energy and is constrained to approach the theoretical high-energy limit. The incoherent-scattering cross sections are approximated by the Klein–Nishina relation, which is represented here by a simple rational function. Results are also shown graphically and provide readily available approximate cross sections. The graphs also show the source data on which the approximations are based in addition to some results from other compilations for comparison. (100 figures) (auth)

21280 ATOMIC DEUTERIUM MASER. Wineland, D. J.; Ramsey, N. F. (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 5: No. 2, 821-37(Feb 1972).

An atomic deuterium maser operating on hyperfine transitions was used to measure the ground-state hyperfine separation in deuterium. The result was $\nu_0(D)$ = 327 384 352.5222(17) Hz where the hydrogen hyperfine frequency is assumed to be exactly 1420 405 751.768 Hz. The construction of the device is discussed and a theory of the deuterium maser is presented with special attention given to frequency shifts occurring in the output frequency. In addition, a possible shift of the deuteron Larmor frequency because of the earth's gravitational field was also investigated and found to be $<10^{-4}$. (auth)

21281 LIFETIMES, g FACTORS, AND COLLISION CROSS SECTIONS OF HYDROGEN MOLECULES IN THE $(1s3p)\ ^3\Pi_u$ LEVEL. Marechal, M. A.; Jost, R.; Lombardi, M. (Univ., Grenoble, France). Phys. Rev., A; 5: No. 2, 732-9(Feb 1972).

Experimental results obtained by Hanle and Bitter–Brossel effects on the N = 1 and N = 2 (v = 0, 1, 2, and 3) levels of the $(1s3p)\ ^3\Pi_u$ state of the parahydrogen molecule excited by electron impact are presented. Resonances are found at the experimentally lowest possible frequencies (21 to 64 MHz) in a region where the N–S decoupling is nonexistent for the N = 2 level (the measured Landé g factors are 0.77 ± 0.01 and 0.48 ± 0.02 corresponding to a pure Hund's-coupling case) and just beginning for the N = 1 level (at 21 MHz the apparent measured g is 1.235 ± 0.01). These re-

sults together with the calculations carried out in the case of complete N−S coupling lead to lifetimes $\tau = (3.10 \pm 0.3) \times 10^{-8}$ s (N = 1) and $\tau = (3.15 \pm 0.3) \times 10^{-8}$ s (N = 2) and $H_2^+ - H_2$ cross sections $\sigma = 232 \pm 30$ Å^2 (N = 1) and $\sigma = 240 \pm 30$ Å^2 (N = 2). The quantities g, τ, and σ were all found to be independent of the vibrational number. Risk of cascade was eliminated. (auth)

21282 FINE STRUCTURE OF THE N = 1 (1s3p) $^3\Pi_u$ STATE OF THE HYDROGEN MOLECULE DETERMINED BY MAGNETIC RESONANCE. Jost, R.; Marechal, M. A.; Lombardi, M. (Univ., Grenoble, France). Phys. Rev., A; 5: No. 2, 740-6(Feb 1972).

In the preceding paper some results on magnetic-resonance experiments performed at 64 MHz indicated a beginning of N−S decoupling in the N = 1 (1s3p) $^3\Pi_u$ state of H_2 excited by electron impact. In the present paper further results are presented on the resonance experiments performed at higher frequencies in order to determine the fine structure of this level. These findings indicate that the energy separation between J = 1 and J = 2 levels is 160 ± 5 MHz and between J = 1 and J = 0 levels it is 2100 ± 600 MHz, and in addition the former exhibits a small dependence on the vibrational number. The relative order of these levels is J = 1, 2, 0 instead of the theoretically predicted 2, 1, 0. The Landé g factor is 1.249 ± 0.010, which corresponds to a pure Hund's-coupling case. (auth)

21283 K-SERIES X-RAY ENERGIES AND INTENSITIES FOR CURIUM, BERKELIUM, CALIFORNIUM, AND EINSTEINIUM. Dittner, P. F.; Bemis, C. E. Jr. (Oak Ridge National Lab., Tenn.). Phys. Rev., A; 5: No. 2, 481-4(Feb 1972).

The energies of the $K\alpha_1$, $K\alpha_2$, $K\beta_1$, and $K\beta_3$ x rays of Cm, Bk, Cf, and Es, arising in the decay of suitable parent radioactivities, were measured with a high-resolution Ge(Li) photon detector. The K-shell binding energies of Cm, Bk, and Cf were determined using previously published values for the L_{II}-, L_{III}-, M_{II}-, and M_{III}-shell binding energies. The relative transition probabilities ($K\alpha_1 = 1000$) of the K-series lines were determined for Cm, Bk, Cf, and Es. The measured energies and relative transition probabilities agree well with recent theoretical predictions. (auth)

21284 COMBINED ZEEMAN AND HIGH-FREQUENCY STARK EFFECTS, WITH APPLICATIONS TO NEUTRAL-HELIUM LINES USEFUL IN PLASMA DIAGNOSTICS. Hicks, William W.; Hess, Roger A.; Cooper, William A. (Univ. of California, Berkeley). Phys. Rev., A; 5: No. 2, 490-507(Feb 1972).

The theory of the high-frequency Stark effect in atomic spectra is extended to treat cases of multiple interacting upper levels and of strong electric fields and resonances, where perturbation theory is inadequate. The effects of a static external magnetic field are also included both in the perturbation theory and the more general treatment. Numerical calculations are presented for the 4922- and 4388-Å lines of He I for several field strengths and frequencies. The new theory is used to infer the frequency and strength of a microwave electric field applied to a steady-state helium discharge with no magnetic field; excellent agreement is obtained between the calculated and the observed spectra. (auth)

21285 ACCURATE ANALYTIC STATIC AND DYNAMIC POLARIZABILITIES FOR H^- VIA THE ASYMPTOTIC APPROXIMATION. Adelman, S. A. (Havard Univ., Cambridge, Mass.). Phys. Rev., A; 5: No. 2, 508-14(Feb 1972).

Accurate closed analytic expressions for certain properties of H^- that strongly depend on the long-range tail of its wave function are given. These properties are $\langle r_1^n + r_2^n \rangle$, the static electric multipole polarizabilities, and the dynamic dipole polarizability. From the last, the H^- photodetachment cross section is calculated and the simple but accurate result obtained by Armstrong is recovered. The only assumption made is that the exact wave function can be replaced by its rigorous asymptotic form, for the purpose of calculating these properties. No model potentials or arbitrary cutoffs are introduced. The results for the dipole polarizabilities agree to better than 5% with the extensive recent calculations of Chung. For $\langle r_1^n + r_2^n \rangle$, $n \geq 2$, the formula obtained agrees to within 0.5% with values obtained from large calculations. For all these quantities, the Hartree–Fock results are far inferior. (auth)

21286 L_{II} SUBSHELL YIELDS OF URANIUM AND RADIUM. Gil, F. B.; Barroso, A.; Soares, J. C.; Ferreira, J. G. (Univ., Lisbon). Phys. Rev., A; 5: No. 2, 536-41(Feb 1972).

Fluorescence (ω_2), Auger (a_2), and Coster–Kronig (f_{23}) L_{II}-subshell yields, and the total L fluorescence yield ($\bar{\omega}_L$), in uranium and radium were determined from measurements of L x rays emitted following α decay of ^{238}Pu and ^{228}Th, respectively. Alpha x-ray coincidence techniques employing a surface-barrier detector for the α particles and a Si(Li) L x-ray spectrometer and a NaI (Tl) scintillation counter for the L x rays were used. The experimental results are $\omega_2 = 0.423 \pm 0.023$, $a_2 = 0.522 \pm 0.056$, $f_{23} = 0.07 \pm 0.05$, and $\bar{\omega}_L = 0.442 \pm 0.012$ for uranium, and $\omega_2 = 0.415 \pm 0.027$, $a_2 = 0.571 \pm 0.084$, $f_{23} = 0.01 \pm 0.07$, and $\bar{\omega}_L = 0.404 \pm 0.024$ for radium. (auth)

21287 DETERMINATION OF THE ATOMIC-HYDROGEN FINE STRUCTURE BY LEVEL CROSSING IN THE 2P STATES OF HYDROGEN: A MEASUREMENT OF THE FINE-STRUCTURE CONSTANT. Baird, J. C.; Brandenberger, John; Gondaira, Kinichiro; Metcalf, Harold (Brown Univ., Providence). Phys. Rev., A; 5: No. 2, 564-87(Feb 1972).

The Sommerfeld fine-structure constant α was determined from a direct measurement of the fine-structure separation in the 2P states of atomic hydrogen using the level-crossing technique. From the changes in resonance fluorescence caused by level crossing at 3484 G, values for the fine-structure separation $E(^2P_{\frac{1}{2}}) - E(^2P_{\frac{3}{2}}) = 10{,}969.13(0.10)$ MHz and $\alpha^{-1} = 137.0354(6)$ were obtained. The quoted uncertainty represents an estimate of 70% confidence from the analysis of 84 separate runs. (auth)

21288 FINE STRUCTURE AND DIAMAGNETIC ZEEMAN EFFECT IN He. II. MEASUREMENTS IN THE 4^3P AND 5^3P STATES. Miller, Terry A.; Freund, R. S. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., A; 5: No. 2, 588-91 (Feb 1972).

Transitions between Zeeman levels of fine-structure states of He, excited and aligned by electron impact in a magnetic field, were observed for both the $4p^3P$ and $5p^3P$ states. An improved apparatus reproduced the six previously observed $4p^3P$ resonance lines with an improved signal-to-noise ratio. It also made possible observation of two "forbidden" transitions in the $4p^3P$ state and the eight corresponding transitions in the $5p^3P$ state. The following fine-structure constants were derived: $4^3P_0 - 4^3P_1 = 3306.4 \pm 0.7$ MHz, $4^3P_1 - 4^3P_2 = 270.4 \pm 0.7$ MHz, $5^3P_0 - 5^3P_1 = 1660.0 \pm 0.8$ MHz, $5^3P_1 - 5^3P_2 = 137.4 \pm 0.7$ MHz. The anisotropic portion of the diamagnetic Zeeman interaction was measured and used to derive values for the atomic radius and quadrupole moment. These values are larger than the corresponding expectation values calculated from hydrogenic orbitals. Further calculations and experiments are planned to determine if these discrepancies are apparent or real. (auth)

21289 CONVERGENCE OF THE 1/Z EXPANSION. Ahlrichs, Reinhart (Univ. of Chicago). Phys. Rev., A; 5: No. 2, 605-14(Feb 1972).

Lower bounds to the convergence radii of the 1/Z expansions are reported for some low-lying states of the isoelectronic series of the helium and lithium atom. It is proven for the first time that the 1/Z expansion converges for the ground state of the helium atom. The investigation of the 1^2S and 1^2P_u states of the lithium atom indicated poor convergence properties of the 1/Z expansion for systems with more than two electrons. The Brillouin–Wigner perturbation expansion of the ground state of the helium atom is shown to converge if $1/(Z - \sigma)$ is used as perturbation parameter for $\sigma = 0.34$. (auth)

21290 RADIATIVE TRANSITION RATES FROM THE 2p3p ^3P AND 2p3d $^{1,3}D$ STATES OF THE HELIUM ISOELECTRIC SEQUENCE. Drake, G. W. F. (Univ. of Windsor, Ont.). Phys. Rev., A; 5: No. 2, 614-9(Feb 1972).

The Hylleraas–Scherr–Knight variation–perturbation method is applied to the calculation of oscillator strengths for the dominant transitions from the metastable 2p3p ^3P and 2p3d $^{1,3}D$ states of helium and the helium-like ions. The results explain the absence of the 1s2p $^3P - 2p3_D$ ^3P transition of He I from recent beam–foil excitation spectra. (auth)

21291 SEPARABLE POTENTIALS MODEL AND POTENTIAL CURVES FOR H_2^-. Ostrovskii, V. N. Vestn. Leningrad. Univ., No. 10, Fiz., Khim.; No. 2, 16-21(May 1971). (In Russian).

The nonlocal separable potential has been proposed as a model for atomic potentials. This model, which allows exact solution, may be considered as a direct generalization of the extensively used zero-range-potential model. It makes it possible to account for a non-zero range of the atomic field. The model is applied to the calculation of potential-energy curves and widths of the H_2^- molecular ion. (auth)

21292 VACUUM-UV LASER ACTION OBSERVED IN H_2 WERNER BANDS: 1161 TO 1240 A. Hodson, R. T.; Dreyfus, R. W. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev. Lett.; 28: No. 9, 536-9(28 Feb 1972).

Stimulated emission has been observed in the Q1 and some P_3 lines of the $v' \rightarrow v'' = 1-4$, 2–5, 2–6, and 3–7 Werner bands

($C^1\Pi_u \rightarrow X^1\Sigma_g^+$) of molecular hydrogen near 1200 Å. Light pulses of approximately 1 ns duration were produced by bombarding hydrogen gas with ~400-keV electrons from a commercial electron-beam generator. (auth)

21293 OBSERVATIONS OF GAIN BY STIMULATED EMISSION IN THE WERNER BAND OF MOLECULAR HYDROGEN. Waynant, Ronald W. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 28: No. 9, 533-5(28 Feb 1972).

Stimulated emission of vacuum ultraviolet radiation was observed on two Q1 lines in the Werner band ($C^1\Pi_u \rightarrow X^1\Sigma_g^+$) of molecular hydrogen. These lines, 1161 and 1230 Å, contain 5 kW peak power and were produced by a traveling-wave discharge system. Using this excitation principle, evidence of gain was obtained by observations of optimum velocity matching at pulse velocities less than c. (auth)

21294 CHARACTERISTICS OF THE He II n = 4–5 (10,124 A) AND n = 4–6 (6560 A) LINE COMPLEXES IN A LOW-TEMPERATURE HOLLOW CATHODE. Kessler, E. G., Jr.; Roesler, F. L. (Univ. of Wisconsin, Madison). J. Pot. Soc. Amer.; 62: No. 3, 440-6(Mar 1972).

The He II n = 4–5 (10 124 Å) and n = 4–6 (6560 Å) line complexes, not previously studied at high resolution, were excited in a liquid-nitrogen-cooled hollow cathode and observed with a double Fabry–Perot spectrometer. Relative positions, relative intensities, and widths of the fine-structure components were determined by computer analysis of the digitally recorded spectra of both ^{3}He and ^{4}He. The relative positions of the best-resolved components were determined to ± 0.002 cm^{-1} and show agreement with theoretical fine structures and isotope shifts. The accuracy of the position measurements is limited by the highly blended nature of the transitions, there being 19 broadened components over a 1.1 cm^{-1} range. The observed relative intensities approximated statistical relative intensities except for components arising from S and P states, which were three to five times more intense than the theoretical values. The measured widths of the ion lines are roughly 1.15 times those observed for He I lines. The intensity and width results are consistent with observations previously reported for the He II n = 3–4 (4686 Å) transition and support the conclusions on the excitation mechanisms that were inferred from a study of that transition. (auth)

21295 DIRECT TRANSITIONS AT OPTICAL FREQUENCIES IN RARE-EARTH METALS. Petrakian, J. P. (Univ., Provence, Marseille). J. Opt. Soc. Amer.; 62: No. 3, 401-10(Mar 1972).

Heavy rare earths in thin films depart from light-rare-earth behavior by exhibiting two absorption maxima. One of those is located between 2.5 and 3.5 eV and exists in heavy rare earths only. An electronic transition between energy bands explains the presence of this maximum; plasma oscillations are not consistent with the data. The other absorption peak, located at 5.7 eV, is characteristic of all lanthanide elements. The 4f electrons are not responsible for it; a $M_2^- \rightarrow M_4^+$ transition is more likely. (auth)

21296 RESONANCE LINES OF Ce V AND Ce VI. Reader, Joseph (National Bureau of Standards, Washington, D. C.); Ekberg, Jan Olof. J. Opt. Soc. Amer.; 62: No. 3, 464(Mar 1972).

Observed wavelengths and level designations for the resonance lines of Ce V and Ce VI are reported briefly. (A.G.W.)

21297 MULTIPLET STRUCTURE INVESTIGATION OF THE L-SERIES LINES OF RARE EARTH ELEMENTS. Demekhin, V. F.; Platkov, A. I.; Lyubivaya, M. V. (Rostov State Univ., Rostov-on-Don, USSR). Zh. Eksp. Teor. Fiz.; 62: No. 1, 49-56(Jan 1972). (In Russian).

A longwave x-ray spectrograph was used to investigate the L-series lines of rare earth elements in Me_2O_3 oxides. A considerable asymmetry and multiplicity of the $L_{\alpha_{1,2}}$, L_{β_1}, L_{β_2}, and L_{γ_1} lines are observed. A calculation of the multiplet structure of the $d^9 4f^n$ configuration is performed for $58 \leq Z \leq 71$ in the intermediate-coupling approximation. Transition probabilities of 3d and 4d electrons from multiplet levels to the 2p state are calculated. The shapes of the $L_{\alpha_{1,2}}$, L_{β_1}, L_{β_2}, and L_{γ_1} x-ray lines of the rare earth elements in Me_2O_3 oxides are explained. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 21427, 21685, and 22075.

21298 (JINR–P14-6118) STUDY OF THE MATTER PROPERTIES USING μ^+ MESONS. Gurevich, I. I.; Meleshko, E. A.; Muratova, I. A.; Nikol'skii, B. A.; Roganov, V. S.; Selivanov, V. I.; Sokolov, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

Papers dealing with the determination of the frequency of hyperfine splitting of the ground state of the muonium free atom in germanium, ice, and quartz are reviewed as well as the results of determining the diffusion coefficient for positive muons in copper. (8 references) (auth)

21299 INVESTIGATION OF THE MUONIUM STAGE OF μ^+ MESON DEPOLARIZATION IN POTASSIUM CHLORIDE. Ivanter, I. G.; Minaichev, E. V.; Myasishcheva, G. G.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 14-20(Jan 1972). (In Russian).

Residual polarization of μ^+ mesons in potassium chloride single crystals was measured as a function of the longitudinal magnetic field strength between 0 and 3 kOe. Experimental results agree with the phenomenological theory of the muonium stage of μ^+ meson depolarization in matter in the presence of spin-exchange interactions between muonium and the medium. The measured value of the "critical" magnetic field strength, H = 1540 ± 60 Oe, is identical to the vacuum value. The data obtained indicate that atomic muonium reacts chemically and forms a diamagnetic compound. The relation between spin-exchange (ν) and chemical ($1/\tau$) process rates is expressed in terms of the product $\nu\tau$ = 1.81 ± 0.10. A number of processes that complicate the investigation of the purely muonium stage of μ^+ meson depolarization in matter are discussed. (auth)

21300 SOME IMPLICATIONS OF A RECENT TEST OF MUONIC-ATOM THEORY. Rinker, George A. Jr.; Rich, Marvin (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 28: No. 10, 640-2(6 Mar 1972).

It is found that the recent discrepancies observed by Dixit et al. in muonic-atom transition energies can be reproduced by various simple potentials. (auth)

21301 MESIC ATOMS. Devons, Samuel (Columbia Univ., New York). pp 619-50 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A review is presented of mesic atoms since the time of the development of the Ge–Li gamma detector. The emphasis is on muonic atoms and their electromagnetic aspects. The accuracy of measurements and the electrodynamic corrections are discussed. "Isotope" shifts and their interpretation are considered. Weak interactions and pionic and kaonic mesic atoms are also considered briefly. 22 references. (D.L.C.)

21302 ISOMER SHIFTS IN MUONIC ATOMS. Backe, H.; Engfer, U.; Jahnke, U.; (and others) (CERN, Geneva). pp 723-8 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

For a number of medium and heavy nuclei, prompt nuclear γ rays in muonic atoms have been measured, and the energy shifts ΔE_{exp} of these γ rays compared to the corresponding γ lines from radioactive sources are tabulated. The effects of isomer shifts, magnetic hyperfine interaction, and nuclear polarization on these shifts are calculated. (D.L.C.)

21303 OBSERVATION OF E2 X-RAY TRANSITIONS IN MUONIC ATOMS. Backe, H.; Engfer, R.; Jahnke, U.; (and others) (CERN, Geneva). pp 729-32 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The 3p–1s E1 transitions and 3d–1s E2 transitions in muonic ^{209}Bi were studied at an energy of 8.4 to 8.6 MeV. The delayed γ spectrum was measured simultaneously with the prompt x-ray spectrum. The fine structure components and the intensities were calculated. (D.L.C.)

Collision Phenomena

Refer also to abstracts 21177, 21281, 21348, 21349, 21352, 21552, 22065, and 22066.

21304 (GULF-RT-A-10848) ENERGY DEPOSITION STUDIES. Annual Report, September 1, 1970–August 31, 1971. Vroom, David A. (Gulf Radiation Technology, San Diego, Calif.). 30 Sep 1971. Contract AT(04-3)-167. 63p. Dep. NTIS.

Progress during the period on measurement of energy and angular distributions of electrons ejected from atoms and molecules in the gaseous state by photons and electrons is reported. Changes and modifications in equipment and efforts to explain differences between previous measurements and measurements of others are described. Data on the following are presented in the form of figures and tables: angular distributions of photoelectrons emitted from H_2, N_2, Ar, N_2–Ar, H_2O vapor, and NO; integrated and differential cross sections for production of secondary electrons by impact of 2.5-, 5.0-, 7.5-, and 10-keV electrons on N_2; integrated and differential cross sections for production of secondary electrons by impact of 2.5- and 5.0-keV electrons on H_2O vapor; angular distribution of secondary electrons produced by impact of 2.5-, 5.0-, and 7.5-keV electrons on N_2 and by 2.5- and 5.0-keV electrons on H_2O vapor. A preliminary report on a theoretical study of electron energy deposition in gases and solids is included as an appendix. (A.G.W.)

21305 (SC-RR-710784) TOTAL CROSS SECTIONS FOR CHARGE TRANSFER AND STRIPPING OF Al, Cr, AND Er IONS IN He AND N_2. Lockwood, Grant J. (Sandia Labs., Albuquerque, N. Mex.). Jan 1972. 22p. Dep. NTIS.

Absolute measurements are reported here of the total cross sections for charge transfer and stripping of Er^+, Er^{2+}, Al^+, and Cr^+ on He and N_2 in the energy range from 15 keV to 100 keV. These measurements include σ_{10}, σ_{12}, and σ_{21}. The σ_{12} cross sections are greater than the σ_{10} cross sections at the same velocity for all ions except Cr^+. The charge-transfer cross sections σ_{10} have a velocity dependence that is not predicted by the simple adiabatic criterion. (auth)

21306 MAKING A MEDIUM TRANSLUCENT TO RADIATION EXCITED BY A DIRECTED STREAM OF ATOMIC PARTICLES. Afrosimov, V. V.; Gordeev, Yu. S.; Lavrov, V. M.; Ogurtsov, G. N. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 14: No. 7, 275-8(5 Oct 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 7, 408-11(5 Oct 1971).

Differential cross sections for emission of the 1066.7-Å line of argon excited by impact with 2-keV K^+ ions were measured. From the data obtained the shape of the 1066.7-Å line was calculated as a function of angle of observation. It is concluded that the effects of kinematics of the atomic collisions, as compared with electron–Ar collisions, on the shape of the spectral lines are an appreciable increase of the transparency of the absorbing medium and a strong dependence of the absorption on the observation angle. (A.G.W.)

21307 BORN SERIES FOR POTENTIAL SCATTERING. Rabitz, Herschel (Princeton Univ., N. J.). Phys. Rev., A; 5: No. 2, 620-7(Feb 1972).

The Born series for the T matrix is considered with the class of potentials $V(r) = V_0\int_0^\infty dtA(t)e^{-\alpha t}$. An explicit knowledge of A(t) is not necessary since the resulting scattering amplitude can be expressed in terms of V. The exact expressions for the first and second Born approximations are utilized to approximate the general nth-order term in the series. The series is explicitly summed to yield an expression for the scattering amplitude which reduces at high energy to the previous impact-parameter amplitude of Blankenbecler and Goldberger. The continuation of the series beyond its radius of convergence is discussed and exemplified with an exponential potential $V = V_0e^{-r/a}$. A few specific numerical examples are considered to illustrate the behavior of the resulting scattering cross section. Improvement of low-energy total cross sections is noted, particularly for repulsive or weakly attractive potentials. (auth)

21308 COMPTON-PROFILE MEASUREMENTS OF N_2, O_2, AND Ne USING SILVER AND MOLYBDENUM X RAYS. Eisenberger, P. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., A; 5: No. 2, 628-35(Feb 1972).

Compton-profile measurements were performed on O_2, N_2, and Ne using silver and molybdenum radiation. An approach is outlined to correct for the breakdown of the impulse approximation for the 1s core electrons. A detailed relationship involving experimental corrections is specified by which the experimentally measured intensity can be related to the Compton profile. Good agreement is found between the silver and molybdenum results on the long-wavelength side of the Compton profile. Comparison of the Ne experimental results both with Hartree–Fock calculations and calculations that include non-Hartree–Fock correlation effects show that within the experimental error agreement is obtained with the latter calculation. The experimental results for N_2 and O_2 are compared with theoretical calculations. (auth)

21309 CHARGE-EXCHANGE COLLISIONS INVOLVING PSEUDOCROSSING OF POTENTIAL-ENERGY SURFACES. Penner, A.; Wallace, R. (Univ. of Manitoba, Winnipeg, Can.). Phys. Rev., A; 5: No. 2, 639-44(Feb 1972).

Methods developed in previous papers are applied to the description of asymmetric charge exchange involving pseudocrossing of energy levels. These methods represent a substantial advance over other classical low-energy models, which involve either linear trajectories or the assumption of some mean trajectory. (auth)

21310 CROSS SECTIONS FOR THE PRODUCTION OF LYMAN-α RADIATION BY FAST-PROTON IMPACT ON H_2. Hughes, R. H.; King, T. J.; Choe, Song-sik (Univ. of Arkansas, Fayetteville). Phys. Rev., A; 5: No. 2, 644-7(Feb 1972).

Absolute cross sections were measured for the production of Lyman-α radiation by proton impact on H_2 in the energy range from 20 to 120 keV. Radiation from slow H atoms produced by dissociative excitation of the H_2 molecule was separated from the radiation from fast hydrogen atoms produced by electron capture by using a Doppler-shift technique. Reasonable agreement is obtained with other investigators where the cross sections overlap. The fast-atom emission exhibits a sharp monotonic decrease with energy, characteristic of charge transfer. The slow-atom emission also monotonically decreases with energy but not nearly as rapidly. It is estimated that about 4% of the total charge transfer goes into producing fast atoms in the 2p state. (auth)

21311 EXCITATION OF SEVERAL IMPORTANT METASTABLE STATES OF N_2 BY ELECTRON IMPACT. Borst, Walter L. (Southern Illinois Univ., Carbondale. Univ. of Pittsburgh). Phys. Rev., A; 5: No. 2, 648-56(Feb 1972).

Absolute cross sections for excitation of the $A^3\Sigma_u^+$, $a^1\Pi_g$, and $E^3\Sigma_g^+$ metastable states of N_2 were deduced from previous time-of-flight studies of metastable nitrogen molecules. The cross section for direct excitation of the $A^3\Sigma_u^+$ state was determined from threshold to 40 eV and was found to have a peak value of $(5.3^{+4.0}_{-2.0}) \times 10^{-17}$ cm^2 near 11 eV. The total apparent cross section of the $A^3\Sigma_u^+$ state was obtained by adding cascade contributions from the $B^3\Pi_g$ and $C^3\Pi_u$ states and was found to have a value of about 1.2×10^{-16} cm^2 at the two peaks near 11.0 and 14.5 eV. The $E^3\Sigma_g^+$ state was efficiently excited near threshold and exhibited a resonance-like excitation function with a half-width at about 0.4 eV and a peak cross section of $(7.0 \pm 4.0) \times 10^{-18}$ cm^2 at 12.2 eV. The excitation function for the $a^1\Pi_g$ state was obtained from threshold to about 40 eV and was found to differ markedly from two other measurements. Using the present results, a sample vibrational distribution for noninteracting molecules in the $A^3\Sigma_u^+$ state was calculated at selected electron energies near threshold. For most energies, the lowest vibrational levels are most strongly populated in qualitative agreement with atmospheric observations. (auth)

21312 PRODUCTION OF LYMAN-ALPHA RADIATION BY 20- TO 120-keV HYDROGEN-ATOM IMPACT ON He, Ne, Ar, AND N_2. Hughes, R. H.; Choe, Song-sik (Univ. of Arkansas, Fayetteville). Phys. Rev., A; 5: No. 2, 656-9(Feb 1972).

Absolute cross sections were determined for the production of Lyman-α radiation by 20- to 120-keV ground-state hydrogen atoms impacting on He, Ne, Ar, and N_2. Atom impact on He follows the predicted energy dependence of Levy's Born wave calculation of 2p excitation beyond 30 keV. Although the experimental value remains about 25% higher than the theoretical value in this region, the agreement is well within experimental error. For Ne, Levy's scaled Born calculation for 2p excitation agrees reasonably well with experiment. However, it is particularly apparent for impact on Ar that the scaled Born calculation underestimates the excitation at the higher energies. All cross sections decrease more rapidly with energy initially than at the higher energies, where a characteristic flattening of the cross-section-vs-energy curve occurs, suggesting the importance of simultaneous excitation of the target and projectile atoms at these energies. (auth)

21313 DIFFERENTIAL CROSS SECTIONS WITH SPIN ANALYSIS FOR $4^2S_{1/2} - 4^2P_{1/2,3/2}$ EXCITATION OF POTASSIUM BY ELECTRONS. Goldstein, Marvin; Kasdan, Abraham; Bederson, Benjamin (New York Univ.). Phys. Rev., A; 5: No. 2, 660-8(Feb 1972).

The atomic-beam recoil technique was used to obtain the ratio of spin-flip to full differential cross sections for $4^2S_{1/2} - 4^2P_{1/2,3/2}$ excitation in potassium by electrons. Data are presented at energies of from 3 to 10 eV, and for electron scattering angles of from $\theta \approx 0°$ to 20°, in 5° intervals. Additional data at $\theta \approx 0°$, for energies from threshold to 20 eV, are also presented. Appropriate

scattering amplitudes are calculated using the Born, Ochkur, and close-coupling approximations, and comparison with these experiments is made. Exchange is necessary to account for the $\theta \approx 0°$ data; the close-coupling results are in fair agreement with all of the angular data, while the Ochkur approximation gives good agreement at very small angles. (auth)

21314 DIFFERENTIAL ENERGY AND ANGULAR CROSS SECTIONS FOR IONIZATION BY SEVERAL-HUNDRED-keV ELECTRONS: THEORY AND COMPARISON WITH EXPERIMENT. Cooper, John W.; Kolbenstvedt, H. (National Bureau of Standards, Washington, D. C.). Phys. Rev., A; 5: No. 2, 677-87(Feb 1972).

A procedure for calculating cross sections for ionization of electrons in various shells of an atom differential in both angle and final electron energy is developed. Calculations for ionization of carbon, copper, and gold for incident energies in the range 100 to 400 keV are presented and compared with recent experimental results. (auth)

21315 THOMAS–FERMI–DIRAC CALCULATIONS OF INCOHERENT-SCATTERING FACTORS. Mendelsohn, Lawrence B. (Polytechnic Inst. of Brooklyn. Sandia Labs., Albuquerque, N. Mex.); Biggs, Frank. Phys. Rev., A; 5: No. 2, 688-91(Feb 1972).

The incoherent-scattering factor (S) derivation of Heisenberg is extended to include the Thomas–Fermi–Dirac (TFD) model of the atom. TFD neutral-atom calculations of the electron densities and potentials are made with the use of a slope-iteration scheme. The calculations of S show that the TFD values of S are much smaller than the Thomas–Fermi values for small momentum transfers and, therefore, are in better agreement with Hartree–Fock values. The improvement is much greater for small-Z atoms. A comparison of Hartree–Fock and TFD S values is given over a wide range of momentum transfers for the rare gases. (auth)

21316 FORMATION OF H(2p) AND H(2s) IN COLLISIONS OF PROTONS AND HYDROGEN ATOMS WITH HYDROGEN MOLECULES. Birely, J. H.; McNeal, R. J. (Aerospace Corp., El Segundo, Calif.). Phys. Rev., A; 5: No. 2, 692-701(Feb 1972).

Cross sections for emission of Lyman-α radiation owing to formation of H(2p) and H(2s) in collisions of 5- to 25-keV protons and hydrogen atoms with molecular hydrogen were determined. The intensity of Lyman-α emitted spontaneously from H(2p) was measured at 54.7° or 125.3° with respect to the projectile beam in an essentially field-free collision chamber with an oxygen-filtered photometer calibrated by reference to previous results for H^+ on Ar. The narrow bandwidth of the oxygen filter allowed separation of the Doppler-shifted Lyman-α, emitted by H(2p) formed in electron capture by fast incident protons or collisional excitation of fast incoming hydrogen atoms, and the virtually unshifted Lyman-α emitted by the far slower H(2p) produced in dissociative excitation of H_2. The increase in intensity of Lyman-α when an electric field, oriented in the direction of the beam, was applied within the collision chamber was used to derive separate cross sections for formation of H(2s) owing to projectile and dissociative excitation. The experimental configuration was designed to minimize the effect of polarization of the light emitted from H(2p) and H(2s), and, after small corrections for cascade effects, the data yield cross sections for population of these states. The total cross section for formation of H(n = 2) via projectile excitation exceeds that for dissociative excitation in either H^+ or H impact. H^+ is generally more efficient than H in the production of Lyman-α at low energies in projectile excitation and at all energies in dissociative excitation, and the cross section for formation of H(2p) usually exceeds that for H(2s). Scaling relationships from limiting high-energy-scattering theory are found to have only moderate success in relating these results to previous measurements involving excitation of H to the n = 3 and 4 states in projectile excitation and as well as in dissociative excitation by other heavy particles. (auth)

21317 VIBRATIONAL EXCITATION OF H_2 BY PROTON IMPACT. Herrero, F. A.; Doering, J. P. (Johns Hopkins Univ., Baltimore). Phys. Rev., A; 5: No. 2, 702-12(Feb 1972).

The forward-scattered component of the absolute cross sections for proton- and deuteron-impact excitation of the first four vibrational levels of the electronic ground state of H_2 was measured. Excitation cross-section measurements are reported for laboratory energies from 100 to 1500 eV; and, for energies below 100 eV, excitation cross sections are reported for forward-scattered protons from $\theta = 0°$ to $\theta = 1.9°$. The cross sections were measured from the peak intensities observed in the ion energy-loss spectra generated by passing a high-quality proton beam (energy spread <80 MeV, angular divergence $\leq \pm 1°$) through a collision chamber containing the target gas at room temperature. Each excitation cross section ($\sigma_{0v'}$, where the quantum number v' refers to the final energy level) is found to reach a maximum value at an energy that decreases with increasing quantum number v': σ_{01}(max) = 1.37×10^{-16} cm^2 at 200 eV, σ_{02}(max) = 0.342×10^{-16} cm^2 at 140 eV, and σ_{03}(max) = 0.078×10^{-16} cm^2 and σ_{04}(max) = 0.021×10^{-16} cm^2 both at 110 eV. These maxima give collision times and distances consistent with the adiabatic hypothesis. For energies beyond the maxima, the cross sections decrease very slowly with increasing energy. Furthermore, the cross sections for excitation to the higher levels decrease more rapidly than the cross sections for excitation to the lower levels, an effect predicted by Shin in a three-dimensional calculation involving a semiclassical theory for the excitation of a classical harmonic oscillator. A comparison of these results with vibrational excitation studies of other systems demonstrates the unique features of the H^+–H_2 system. The large values of these vibrational excitation cross sections and their wide effective kinetic-energy span show that vibrational excitation must be an important process in a wide variety of physical phenomena. (auth)

21318 MEASUREMENTS OF ENERGY AND ANGULAR DISTRIBUTIONS OF SECONDARY ELECTRONS PRODUCED IN ELECTRON-IMPACT IONIZATION OF HELIUM. Peterson, W. K.; Beaty, E. C.; Opal, C. B. (Univ. of Colorado, Boulder). Phys. Rev., A; 5: No. 2, 712-23(Feb 1972).

The energy and angular distributions of electrons produced in the ionization of helium by electrons with energies between 100 eV and 2 keV were measured in a crossed-beam apparatus consisting of a fixed hemispherical energy analyzer and a rotatable electron gun. Distributions of secondary electrons (those electrons departing with energies less than one-half that of the incident primary electrons) were obtained for a wide range of energies and for angles between 30° and 150° with respect to the direction of the incident primary electron beam. The observed angular distributions were significantly different from the results of two early electron-impact measurements; however, they agreed to the extent expected with more recent results and with similar proton-impact data. For secondary energies above about 50 eV and for primary energies greater than 300 eV, the energy distributions (the cross sections integrated over angle) were observed to be very nearly equal to the distribution given by the Mott formula for free-electron–free-electron scattering multiplied by the number of electrons in the target. (auth)

21319 THREE-BODY ATTACHMENT IN O_2 USING ELECTRON BEAMS. Spence, D.; Schulz, G. J. (Yale Univ., New Haven). Phys. Rev., A; 5: No. 2, 724-32(Feb 1972).

The three-body attachment reaction in O_2, $e + 2O_2 \rightarrow O_2^- + O_2$, is studied by electron-beam techniques. Whereas swarm experiments show a smooth variation of the attachment coefficient with energy, the present electron-beam experiment shows pronounced structure. The peaks of this structure occur at the positions of the vibrational levels of the O_2^- system, which serve as compound states and have been identified in a previous experiment. These compound states dominate the low-energy cross sections in O_2. They can decay by autodetachment, thus accounting for the bulk of the vibrational cross sections in O_2 at low energy; alternatively, they can be stabilized by a subsequent collision, thus leading to the formation of stable O_2^-. Thus it is established clearly that three-body attachment in O_2 is a two-stage process and that the intermediate is a vibrationally excited state of O_2^-. The temperature dependence of the three-body attachment coefficient is also obtained, and the anomalous behavior at higher pressures is discussed. The experimental observations are in excellent agreement with the theory of Chapman and Herzenberg. (auth)

21320 EXCITATION OF LITHIUM BY ELECTRON IMPACT USING THE GLAUBER THEORY. Mathur, K. C.; Tripathi, A. N.; Joshi, S. K. (Univ. of Roorkee, India). Phys. Rev., A; 5: No. 2, 746-8(Feb 1972).

The Glauber approximation has been applied to calculate the excitation cross section for the 2s–2p transition in lithium by electron impact using the frozen-core approximation. The integrated inelastic cross section has been compared with other theoretical calculations and with the experimental data. With this frozen-core effectively one-electron formulation of electron–lithium excitation, it is found that the Glauber approximation provides better agreement with experimental data than the Born approximation. (auth)

21321 NATURAL WIDTHS OF KINETIC-ENERGY-LOSS DISTRIBUTIONS IN O^+–Ar AND O^+–Ne COLLISIONS AT 50 TO 200 keV. Rice, James K.; Bingham, Felton W. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., A; 5: No. 2, 749-57(Feb 1972).

A new method for deriving natural widths of kinetic-energy-loss (Q) distributions and a set of natural widths derived by this method

from new experimental data for O^+–Ne and O^+–Ar scattering at 50, 100, and 200 keV are presented. The Q distributions measured by the usual delayed-coincidence techniques are broadened by experimental factors that include the thermal motion of the target gas, the finite slit widths of the scattered-particle collimators, and the energy spread in the incident beam. The present method takes explicit account of these experimental factors in obtaining natural widths from broadened experimentally measured Q distributions. At a given beam energy T_0 and scattering angle, the natural widths are nearly independent of the final charge states of the colliding particles. For O^+–Ar collisions, the natural widths are also independent of r_0, the distance of closest approach of the colliding particles, but they increase with increasing T_0. For O^+–Ne collisions, they increase with decreasing r_0 and with increasing T_0. (auth)

21322 JOST FUNCTION INTERPOLATION OF SCATTERING CROSS SECTIONS. Heller, Eric J.; Reinhardt, William P. (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 5: No. 2, 757-62(Feb 1972).

The analytic properties of the Jost function or Fredholm determinant for single- and many-channel scattering problems suggest that they may often be less rapidly varying functions of the energy than the S matrix or cross sections. This idea is combined with a pointwise rational-fraction interpolation to give a rapidly convergent and highly accurate method of interpolating scattering information over a continuous range of energies. Narrow resonances are easily found by examination of the zeros of the real part of the Fredholm determinant. (auth)

21323 EFFECT OF CHARGE POLARIZATION ON INELASTIC SCATTERING: DIFFERENTIAL AND INTEGRAL CROSS SECTIONS FOR EXCITATION OF THE 2^1S STATE OF HELIUM BY ELECTRON IMPACT. Rice, James K. (Sandia Labs., Albuquerque, N. Mex.).; Truhlar, Donald G.; Cartwright, David C.; Trajmar, Sandor. Phys. Rev., A; 5: No. 2, 762-82(Feb 1972).

Experimental differential scattering cross sections for excitation of helium by electron impact from its ground state to its 2^1S state are presented at four incident electron energies in the range 26 to 55.5 eV for scattering angles between 10° and 70° and at 81.6 eV for scattering angles between 10° and 80°. These differential cross sections are normalized by using previously determined 2^1P cross sections and measured $2^1S/2^1P$ cross section ratios. These experimental cross sections and cross-section ratios are compared with results predicted by the Born approximation, the polarized Born approximation, and several other first-order approximations in which direct excitation is calculated in the Born approximation and exchange scattering in various Ochkur-like approximations. Calculations based on these approximations are also compared to the data of other experimenters at energies up to 600 eV. The effect on the small-angle scattering of several nonadiabatic dipole-polarization potentials is examined. For the 34- to 81.6-eV energy range, it is shown that the inclusion of polarization is necessary for accurate predictions of the angle dependence of the 2^1S cross sections at small angles. Cross sections resulting from the use of analytic self-consistent-field wave functions for both the ground and excited states are presented. They agree well with those obtained from more accurate correlated wave functions. (auth)

21324 INCOHERENT X-RAY SCATTERING BY A STATISTICAL ATOM. Parks, Donald E. (Systems, Science and Software, La Jolla, Calif.); Rotenberg, Manuel. Phys. Rev., A; 5: No. 2, 521-6(Feb 1972).

The theory of the homogeneous interacting electron gas is used to derive a functional of the density for the form factor for incoherent scattering of x rays by a statistical atom. The results show a dramatic improvement over an early calculation of Heisenberg who used the Thomas–Fermi model. Detailed calculations of form factors are carried out for several elements (Ar, Cu, Ce, Na) and compared with the results of Hartree–Fock–Slater (HFS) self-consistent wave-function calculations. Whereas the Thomas–Fermi model gives incoherent cross sections that differ at low energies by orders of magnitude from those given by the HFS model, the theory of the homogeneous electron gas yields results that compare within 15% of the HFS results. (auth)

21325 EXCHANGE SCATTERING OF POSITRONIUM ATOMS ON HYDROGEN ATOMS. El-Mosallami, I. Kh. Vestn. Leningrad. Univ., No. 10, Fiz., Khim.; No. 2, 14-15(May 1971). (In Russian).

The Ochkur (1963) formula for calculating the exchange scattering cross section of positronium atoms on hydrogen atoms for $k > 1$ was employed. The elastic exchange scattering cross section was calculated and the results were compared with those obtained by Massey and Mohr and by Fraser ($k < 1$). The inelastic exchange scattering cross section when the hydrogen atom is excited to the 2s state was also calculated. (auth)

21326 COLLISIONAL EXCITATION OF N^+ AT 50 keV. Crandall, D. H.; York, G.; Pol, V.; Park, J. T. (Univ. of Missouri, Rolla). Phys. Rev. Lett.; 28: No. 7, 397-400(14 Feb 1972).

The excitation spectrum of N^+ was observed by examining the energy lost by a 50-keV N^+ beam passing through a He target. The spectrum exhibits dramatic features with large cross sections. Determination of the approximate ratio of metastable to ground-state ions in the primary ion beam permitted measurement of excitation cross sections from both ground-state and metastable N^+ ions colliding with He target atoms. (auth)

21327 NONOBSERVABILITY OF RETARDATION EFFECTS IN VERY LOW-ENERGY HELIUM SCATTERING. Aldridge, J. P.; Skofronick, J. G. (Florida State Univ., Tallahassee). Phys. Rev. Lett.; 28: No. 9, 529-30(28 Feb 1972).

It has been recently suggested that a retardation effect could possibly be observed in very low-energy helium-atom scattering. In this paper calculational results are presented, which show that the effect arises from small changes in the potential near the bowl rather than in the long-range potential. It is indicated that the measurements provide a sensitive measure of the helium interatomic potential. (auth)

21328 OSCILLATIONS IN Na^+–Na CHARGE-TRANSFER CROSS SECTIONS. Dewangan, D. P.; Mukherjee, D. K.; Karmohapatro, S. B. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev. Lett.; 28: No. 10, 583-4(6 Mar 1972).

Total charge-transfer cross sections of fast sodium ions on sodium atoms are calculated by an impact-parameter method using an analytical Hartree–Fock wave function. The results show oscillations in the cross section as a function of the velocity of ions, and they are compared with the experimental result observed by Daley and Perel. (auth)

21329 INVESTIGATION OF INELASTIC PROCESSES OCCURRING DURING COLLISIONS BETWEEN K^+ IONS AND Ar ATOMS. Afrosimov, V. V.; Bobashev, S. V.; Gordeev, Yu. S.; Lavrov, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 62: No. 1, 61-9(Jan 1972). (In Russian).

Excitation and ionization processes and their relative roles in slow ion–atom collisions are studied. For this purpose the differential scattering cross sections, ion inelastic energy-loss spectra, and ultraviolet emission spectra are studied for collisions between K^+ ions and Ar atoms. The initial ion energy is 2.0 keV. Simultaneous use of the differential scattering and spectroscopic techniques made it possible to study both excitation of the energy levels and decay of the respective excited states. Investigation of excitation processes showed that in K^+–Ar collisions $3p^54p$ and $3p^53d$ levels in Ar are excited with highest probability. The cross section for direct excitation of $3p^54s$ Ar levels, notwithstanding that they are the lowest-lying levels, does not comprise more than 5 to 10% of the total cross section for excitation of Ar levels (7×10^{-17} cm^2). In contrast to Ar, the $3p^54s$ levels of the K^+ ion are excited with highest probability. The contribution of cascade transitions to Ar resonance-line excitation is determined; the contribution is significant and is 70 to 90%. Estimates are made of the contributions to the total ionization cross section of direct ionization processes, ionization processes involving excitation of the ion, and autoionization processes. The contributions of the direct ionization process and ionization process with ion excitation do not exceed 5 and 25% respectively. Autoionization processes are of decisive importance in Ar ionization. (auth)

21330 SCATTERING LENGTH OF ZERO-ENERGY POSITRONS BY ATOMIC HYDROGEN. Hashino, Tasuke; Nakazaki, Shinobu (Miyazaki Univ., Japan). Miyazaki Daigaku Kogakubu Kenkyu Hokoku; No. 17, 101-4(Dec 1970). (In Japanese).

The scattering length for elastic scattering of zero-energy positrons by hydrogen atoms is calculated according to the variational method of Kohn together with the higher-order polarization potential given by the Temkin theory. Using Ohmura's trial wave function, which makes explicitly no allowance for the angular correlation between the incident positron and the atomic electron and which depends upon four linear and one exponential parameters, the best value obtained is –1.825 in atomic units. This is only slightly higher than the value –1.92 in atomic units calculated by Houston and Moiseiwitsch by considering virtual positronium formation, and it is higher than the value –2.10 in atomic units calculated by Schwartz. (auth) (Japan)

21331 ELECTRON EXCITATION FOR THE $2s \rightarrow nf$ TRANSITIONS IN LITHIUM-LIKE IONS. Petrini, D. (Univ. of Maryland, College Park). Astron. Astrophys.; 17: No. 3, 410-12(Mar 1972).

Coulomb–Born I cross sections were evaluated for the $2\,s \rightarrow nl$ ($n = 4, 5, 6$; $l = 0, 1, 2, 3$) transitions in the lithium sequence. (auth)

21332 EXCITATION BY PROTON IMPACT OF FINE STRUCTURE TRANSITIONS IN POSITIVE IONS OF p^2 CONFIGURATION. Masnou-Seeuws, F.; McCarroll, R. (Observatoire, Meudon, France. Univ., Bordeaux). Astron. Astrophys.; 17: No. 3, 441-4(Mar 1972).

Proton-induced transitions among the fine structure states of positive ions are investigated, using semi-classical theory. The corresponding cross sections are calculated for a number of ions with the configuration p^2. Results are presented for the $^3P_0-{}^3P_1$, $^3P_0-{}^3P_2$, and $^3P_1-{}^3P_2$ transitions in N II, O III, Si IX, and Fe XIII. Also given are cross sections for the $^3P_4-{}^3P_4$ transition in Fe XIV. (auth)

21333 ION–MOLECULE REACTIONS. Parker, J. E. (Heriot-Watt Univ., Edinburgh); Lehrle, R. S. J. Mass Spectrom. Ion Phys.; 7: No. 6, 421-69(Dec 1971).

The experimental methods and theoretical interpretations of ion–molecule reactions are reviewed. The reactions are restricted to positive-ion–molecule reactions occurring with reactant-ion relative translational energies of less than ca 3 keV. (325 references) (auth)

21334 PULSED ION CYCLOTRON DOUBLE RESONANCE FOR THE STUDY OF ION–MOLECULE REACTIONS. McIver, Robert T. Jr.; Dunbar, Robert C. (Stanford Univ., Calif.). J. Mass Spectrom. Ion Phys.; 7: No. 6, 471-83(Dec 1971).

A new mass spectrometric technique, pulsed ion cyclotron resonance spectroscopy, is described. The technique is particularly well suited for studying the kinetic-energy dependence of gas-phase ion–molecule reactions. Ions of a given charge-to-mass ratio can be accelerated by a pulsed radiofrequency voltage to kinetic energies up to 40 eV while being trapped in an analyzer cell. A pulse compensator circuit has been developed so that ions of a given mass can be simultaneously irradiated by the pulsed rf and observed with the marginal oscillator–detector. The reaction of CH_4^+ in methane is studied over the kinetic energy range from thermal to 10 eV as a test of the technique. (auth)

21335 DISTRIBUTION OF ROTATIONAL ENERGY LEVELS OF N_2^+ IONS PRODUCED IN IONIZATION OF N_2 MOLECULES BY SLOW ELECTRONS. Polyakova, G. N.; Erko, V. F.; Zats, A. V.; Fogel, Ya. M. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 62: No. 1, 57-60(Jan 1972). (In Russian).

The distribution of $N_2^+(B^2\Sigma_u^+)$ ions with respect to rotational energy levels is studied when the ions are produced by ionization of N_2 molecules by 36- to 300-eV electrons. It is shown that if incidence of the primary electrons on the collision-chamber walls is avoided the distribution of the $N_2^+(B^2\Sigma_u^+)$ ions in rotational energy levels can be described by the Boltzmann formula. Deviations from the formula previously observed can be ascribed to electron-stimulated desorption of the ions from the collision-chamber walls and subsequent charge exchange between the ions and nitrogen molecules. (auth)

21336 DIABATIC STATES OF MOLECULES: QUASI-STATIONARY ELECTRONIC STATES. O'Malley, Thomas F. (Univ. of Connecticut, Storrs). Advan. At. Mol. Phys.; 7: 223-49(1971).

Methods of defining or representing electronic states of molecules involved in collisions are discussed. The so-called diabatic states or quasi-stationary electronic states are considered in relation to the following types of collisions: the Na–Cl problem, charge exchange in He, dissociative recombination and electron attachment, and slow heavy-particle collisions. (27 references) (A.G.W.)

21337 DIFFERENCES IN INNER-SHELL VACANCY PRODUCTION FOR Ar–C COLLISIONS IN GAS VERSUS SOLID TARGETS. Der, R. C. (Univ. of California, Livermore); Kavanagh, T. M.; Fortner, R. J.; Garcia, J. D. Phys. Rev. Lett; 27: No. 24, 1631-4)13 Dec 1971).

X-ray spectra are presented for Ar–C collisions in gas and solid (graphite) targets, for collision energies of 80 and 90 keV. In gas targets, with either carbon or argon as the target, inner-shell vacancies are produced essentially only in the argon L shell. For Ar^+ ions incident on graphite, however, there is a high probability of producing vacancies in the K shell of carbon. These observations are plausibly explained within a diabatic molecular-orbitals framework and lend strong support to such a description. (auth)

21338 IN-FLIGHT X-RAY MEASUREMENTS: TECHNIQUE FOR IDENTIFICATION OF SUPERHEAVY ELEMENTS. Armbruster, P. (Gesellschaft fuer Schwerionenforschung, Darmstadt, Ger.); Mokler, P. H.; Stein, H. J. Phys. Rev. Lett; 27: No. 24, 1623-5(13 Dec 1971).

In energetic heavy-ion–atom collisions there is an extremely high probability for producing electron holes in inner shells of the collision partners. The resulting high x-ray yield opens the possibility of detecting superheavy elements by their collision-induced characteristic x rays. A Z determination of fast recoils with lifetimes longer than 10^{-6} seems to be possible. The applicability of the method is discussed. (auth)

21339 DETERMINATION OF CROSS SECTION FOR CHARGE EXCHANGE AND DEPOLARIZATION IN GASES FROM PERTURBED ANGULAR CORRELATIONS. Gygax, F. N.; Leisi, H. J. (Swiss Federal Inst. of Tech., Zurich). pp 970-2 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The anisotropy of the 172- and 203-keV $\gamma-\gamma$ angular correlation in the decay of gaseous ^{131}Xe was measured as a function of the density of iodine buffer gas. The data can be analyzed in terms of average attenuation factors G_2^1 and G_4^1 which correspond to decays having suffered no collision, and one or more collisions, respectively. The cross sections resulting from the analysis are one and two orders of magnitude larger than the geometrical cross sections. A classical collision model was used in an attempt to explain these large values, and fair agreement was obtained for Xe buffer gas. (D.L.C.)

Atomic Theory

Refer also to abstracts 21291, 21511, and 21512.

21340 (TID-25930) HEAVY ION COLLISION PHENOMENA. Final Report. Wittkower, Andrew (Ion Physics Corp., Burlington, Mass.). Dec 1971. Contract AT(30-1)-4234. 71p. Dep. NTIS.

Copies of papers submitted for publication in the open literature on the following subjects are included: equilibrium charge-state distributions of 2- to 15-MeV Ta and U ions stripped in gases and solids, equilibrium charge-state distributions of U ions at 2 to 15 MeV, small-angle scattering of Br and U beams in gaseous targets, charge-changing cross sections for heavy ions in complex molecules, and charge-changing cross sections of 5- to 25-MeV iodine ions in hydrogen and oxygen. (A.G.W.)

21341 EXTERNAL ELECTROMAGNETIC INTERACTIONS OF HYDROGENIC ATOMS AND GALILEAN INVARIANCE. Grotch, H.; Kashuban, R. (Pennesylvania State Univ., University Park). Phys. Rev., A; 5: No. 2, 527-36(Feb 1972).

The external electromagnetic interactions of hydrogenic atoms, which exhibit global Galilean invariance but preserve the relativistic description of the electron, are investigated. The Hamiltonian for the free atom consists of the Breit Hamiltonian for a relativistic electron interacting with a nonrelativistic spinless proton. Approximate generators of the Galilean group are constructed in terms of individual-particle position, momentum, and spin operators in several unitarily equivalent representations. In one of these the Hamiltonian is separable in conventional relative and center-of-mass coordinates. This separability facilitates the treatment of a number of external-field problems. An effective Hamiltonian for the interaction of the atom with a constant external electric field is given and compared to that obtained by other authors. The low-energy theorem for Compton scattering from the composite system is explicitly verified including corrections due to atomic binding. This also gives an independent verification of recently obtained bound-state corrections to the atomic magnetic moment. Finally, an effective interaction of a charged Dirac particle with a hydrogenic atom is given in the representation in which the atomic Hamiltonian is separable. (auth)

21342 ANALYSIS OF THE ELECTRONIC EXCHANGE IN ATOMS. Lindgren, Ingvar (Yale Univ., New Haven); Schwarz, Karlheinz. Phys. Rev., A; 5: No. 2, 542-50(Feb 1972).

The Hartree–Fock exchange and the statistical free-electron approximation are analyzed and compared for a number of atoms. The exchange energy is calculated in the two approximations—in both cases by using accurate Hartree–Fock orbitals—and split up into contributions from individual electronic shells and also into self-interaction and interelectronic parts. The results are conveniently expressed by the ratio of the various quantities in the two approximations. It is found that these parameters vary in a simple and regular way, which can be interpreted by means of an extended free-electron model. It is, e.g., found that the parameter of the total self-interaction is significantly larger than that of the total interelectronic exchange. This explains in a simple way the

principal variation with the atomic number of the parameter in the so-called Xα method. The analysis is only intended to yield some insight into the exchange phenomenon, and no new — local or non-local — exchange potential is suggested. (auth)

21343 THEORETICAL STUDY OF GENERALIZED OSCILLATOR STRENGTHS IN ATOMS: COMPARISON WITH EXPERIMENT AND OTHER CALCULATIONS. Manson, Steven Trent (Georgia State Univ., Atlanta). Phys. Rev., A; 5: No. 2, 668-77(Feb 1972).

A central-field approximation is used to calculate generalized oscillator strengths for a number of discrete and continuous transitions in the noble gases, the alkalis, and Hg, where experimental data exist. The comparisons show that this approximation yields good agreement with experiment except for the first few discrete excitations in low-Z and certain high-Z elements, and in the region of large peaks near threshold in continuum transitions. The reasons for the discrepancies are pointed out, in terms of the approximations made, and the usefulness of this type of calculation is discussed. (auth)

21344 UNIVERSAL NATURE OF THE ATOMIC PHOTOABSORPTION CROSS SECTION. Stanton, K. F. (New York Univ., N. Y.). Phys. Lett.; 38A: No. 2, 131-2(17 Jan 1972).

The spatial inhomogeneity of atomic electron-density distributions is shown to affect the photoabsorption cross section, in the statistical approximation of Brandt and Lundqvist, in characteristic ways that are apparent in an updated comprehensive compilation of recent experimental data. (auth)

21345 LADDER APPROXIMATION IN QUANTUM OPTICS AND THE WIGNER-WEISSKOPF THEORY. Knight, P. L.; Allen, L. (Univ. of Sussex, Brighton, Eng.). Phys. Lett.; 38A: No. 2, 99-100(17 Jan 1972).

It is shown that the Wigner-Weisskopf theory is an example of what Walls has called the ladder approximation in quantum optics. (auth)

21346 COLLECTIVE RADIATIVE PROCESSES INVOLVING UNLIKE ATOMS. Varfolomeev, A. A. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 111-18(Jan 1972). (In Russian).

Two-photon emission processes in a system of two unlike atoms with close excited energy levels and located at a fixed distance from each other are considered within the framework of perturbation theory for decaying states. Solutions that describe the behavior of the system during resonance fluorescence and spontaneous decay from an initial state with two excited atoms are obtained. It is shown that resonant interaction between unlike atoms involving excitation exchange leads to complete radiative decay of the system (in contrast to a system of identical atoms) and to the appearance of interference effects that considerably alter the time law of decay and the radiation energy spectra. (auth)

21347 IMPROVED UNCOUPLED HARTREE-FOCK PERTURBATION THEORY. III. DIPOLE SHIELDING FACTORS. Sadlej, A. J. (Inst. of Organic Chemistry, Warsaw). Acta Phys. Pol., A41: No. 2, 173-8(Feb 1972).

The application of the previously proposed uncoupling scheme to the calculation of the mixed-type second-order properties is considered. The first-order perturbed Hartree-Fock orbitals obtained in the electric polarizability calculations are employed for the determination of the dipole shielding factors of 4- and 10-electron atoms and ions. A considerable improvement over the dipole shielding factors calculated by using the Karplus-Kolker first-order perturbed orbitals is obtained. (auth)

21348 ADVANCES IN ATOMIC AND MOLECULAR PHYSICS. VOLUME 7. Bates, D. R.; Esterman, Immanuel (eds.). New York; Academic Press, Inc. (1971). 417p. $22.00.

Separate abstracts were prepared for five of the eight papers included. The remaining papers deal with hydrogen masers, localized molecular orbitals, and theory of liquid metals. (A.G.W.)

For abstracts of individual papers see: 21336 and 21349-21352.

21349 MOLECULAR WAVE FUNCTIONS: CALCULATION AND USE IN ATOMIC AND MOLECULAR PROCESSES. Browne, J. C. (Univ. of Texas, Austin). Advan. At. Mol. Phys.; 7: 47-95(1971).

Methods of computation of molecular wave functions and potential curves are surveyed from the viewpoint of their utility (or potential utility) in the calculation and analysis of atomic and molecular processes. Applications to atom-atom scattering (elastic and inelastic) and to spectroscopic processes and binary collision processes leading to the emission of radiation are reviewed in less detail. (379 references) (A.G.W.)

21350 GENERAL THEORY OF SPIN-COUPLED WAVE FUNCTIONS FOR ATOMS AND MOLECULES. Gerratt, J. (Univ. of Bristol, Eng.). Advan. At. Mol. Phys.; 7: 141-221 (1971).

A theory of spin-coupled wave functions is developed so as to be as general as possible, and its consequences are examined. In particular, an extensive analysis of the spatial symmetry properties of the orbitals is given. Formulas to aid in calculation of coefficients needed for application of the theory are given in an appendix. (90 references) (A.G.W.)

21351 SELECTION RULES WITHIN ATOMIC SHELLS. Judd, B. R. (Johns Hopkins Univ., Baltimore). Advan. At. Mol. Phys.; 7: 251-86(1971).

Null matrix elements that occur in calculations in atomic shell theory are discussed. Their possible interpretation in terms of structure in the atomic shell and their relation to selection rules are considered. (50 references) (A.G.W.)

21352 GREEN'S FUNCTION TECHNIQUE IN ATOMIC AND MOLECULAR PHYSICS. Csanak, Gy. (Univ. of Southern California, Los Angeles); Taylor, H. S.; Yaris, Robert. Advan. At. Mol. Phys.; 7: 287-361(1971).

Ways in which the Green's function technique can be applied to the problems of calculating excitation energies, ionization energies, ground-state energies, transition matrix elements, electron absorption coefficients, frequency-dependent polarizabilities for atomic and molecular systems, and electron-atom and electron-molecule elastic and inelastic scattering cross sections are reviewed. (60 references) (A.G.W.)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

21353 PERIODS OF OSCILLATION OF A ROTATING COLUMN OF LIQUID IN THE PRESENCE OF AN AXIAL MAGNETIC FIELD AND A UNIFORM AXIAL CURRENT. Srivastava, K. M.; Sharma, R. C. (Univ. of Jodhpur, India). Istanbul Univ. Fen Fak. Mecm., Seri A; 34: 47-51(1969).

The periods of oscillation of a rotating column of a perfectly conducting liquid in the presence of an axial magnetic field and a uniform axial current are derived. It is found that the presence of an axial magnetic field and a uniform axial volume current splits each characteristic value (in the absence of the magnetic field and axial volume current) into two. A criterion for the frequencies to be real is also obtained. (auth)

21354 MAGNETOHYDRODYNAMIC STABILITY OF THE DEVELOPING LAMINAR FLOW IN A PARALLEL-PLATE CHANNEL. Chen, T. S.; Eaton, T. E. (Univ. of Missouri, Rolla). Phys. Fluids; 15: No. 4, 592-6(Apr 1972).

Linear stability of the developing laminar flow of an electrically conducting, incompressible fluid in a parallel-plate channel under a transverse magnetic field is investigated. The case of small magnetic Reynolds numbers is treated. The developing flows whose stability characteristics are studied correspond to those induced by a uniform and a parabolic velocity distribution at the channel inlet. The stability of the fully developed Hartmann flow is also reexamined. Neutral stability curves and axial variations of the critical Reynolds number are presented for a range of Hartmann numbers between 0 and 4. It is found that for Hartmann numbers larger than one, the developing flow induced by a uniform inlet velocity distribution is the least stable, while the flow induced by a parabolic inlet velocity distribution could be the most stable in the entrance region of the channel. A comparison with the available experimental data shows that for a given Hartmann number the transition Reynolds number is about two orders of magnitude lower than the critical Reynolds number. (auth)

21355 MAGNITOGIDRODINAMICHESKIE TECHENIYA V KANALAKH. (Magnetohydrodynamic Flows in Channels). Vatazhin, A. B.; Lyubimov, G. A.; Regirer, S. A. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Mathematicheskoi Literatury (1970). 672p.

A detailed account is given of the results of studies of magnetohydrodynamic flows in channels to serve not only as an introduction to the fundamentals of the theory and as a handbook but also as a comprehensive guide in formulating and solving new problems. Some general information concerning magnetohydrodynamics and its applications to the theory of various devices is presented to facilitate the subsequent exposition, which deals primarily with problems which may be regarded as most highly developed and completed. Among the subjects discussed are the theory of flows in a one-dimensional approximation, completely developed laminar flows of viscous incompressible fluid, the development of these laminar flows and boundary layers, the theory of electric fields in channels, and two-dimensional and axisymmetric flows of an inviscid medium. Flows of high-conductivity media, flows in the presence of a very strong magnetohydrodynamic interaction, and flows affected considerably by electrode phenomena are discussed. (IAA)

21356 UNSTEADY MHD DUCT FLOW. Sloan, D. M. (Univ. of Strathclyde, Glasgow). Appl. Sci. Res. (The Hague); 25: No. 1-2, 126-36(Nov 1971).

An exact solution is presented for unsteady laminar flow of a viscous, incompressible, electrically conducting fluid between nonconducting, parallel, flat plates. A constant magnetic field is suddenly applied perpendicular to the plates and the motion is modified by the induced current. Numerical results given show how the velocity profile changes from the parabolic profile of hydrodynamics to the Hartmann profile of magnetohydrodynamics. (auth)

PHYSICS (HIGH-ENERGY)

21357 PARTICLES AND FIELDS, 1971. Proceedings of the Rochester Meeting of APS/DPF, 30 August–2 September, 1971. Melissinos, A. C.; Slattery, P. F. (eds.). AIP Conference Proceedings, Number 2. Particles and Fields Subseries, Number 1. New York; American Institute of Physics (1971). 329p. (CONF-710810).

Twenty-one papers are included dealing with hadronic interactions, weak interactions, cosmology, and field theory. Separate abstracts are prepared for nineteen. Two papers were previously abstracted for NSA and appeared as CONF-710810-3 and -4. (L.B.S.)

For abstracts of individual papers see: 21180, 21207, 21365, 21370, 21371, 21399–21401, 21441–21444, 21461, 21462, 21473, 21481, 21504, 21528, and 21543.

Particle Interactions and Properties (Experimental)

Refer also to abstract 20429.

21358 (COO-3506-1) EXPERIMENTAL STUDIES OF ELEMENTARY PARTICLE INTERACTIONS AT HIGH ENERGIES. Technical Progress Report. Cool, Rodney L. (Rockefeller Univ., New York). Feb 1972. Contract AT(11-1)-3506. 28p. Dep. NTIS.

A proposal that the AGS establish an intense monochromatic neutron beam up to 16 GeV/c by stripping a deuteron beam on an internal Be target and three experiments that can be done with such a beam are discussed. (J.F.P.)

21359 RESULTS FROM STORAGE RINGS. Borgia, B. (Univ., Rome). J. Phys., A (London); 5: No. 2, 179-97(Feb 1972).

A review of experimental results obtained with electron storage rings is presented. The fields of physics investigated by storage rings range from pure quantum electrodynamics to hadron interactions. Particular attention is given to the new aspects brought to light by the results of Adone, in Frascati. (auth) (UK)

21360 POSSIBILITY TO SEARCH FOR QUARKS IN EAS OF COSMIC RAYS. Volovik, V. D.; Ivanov, A. D. (Kharkov State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 121-3(1971). (In Russian).

The remarkable success of SU_3 and higher symmetries, and of the dynamic quark model, promises aid in the search for a fundamental triplet in the free state. A mathematical development is offered which involves the Lorentz factor of secondary particles, and a Landau hydrodynamic model. From the results, it is suggested that rapid oscillations of particle scattering, which may not be noticeable with present-day accuracy, may be caused by very strong influences connecting quarks in hadrons. (K.S.W.)

Electromagnetic

Refer also to abstracts 21038, 21050, 21301–21303, and 21415.

21361 POLARIZED TARGET ASYMMETRY FOR π^0 PHOTOPRODUCTION AT 4 GeV. Booth, P. S. L.; Court, G. R.; Craven, B.; (and others) (Univ. of Liverpool). Phys. Lett.; 38B: No. 5, 339-41(6 Mar 1972).

The polarized target asymmetry parameter was measured for single π^0 photoproduction from hydrogen at 4 GeV and values of four-momentum transfer squared between -0.15 $(GeV/c)^2$ and -1.8 $(GeV/c)^2$. (auth)

21362 ELECTROPRODUCTION OF ρ^0-MESONS ON PROTONS. Driver, C. (Deutsches Elektronen-Synchrotron, Hamburg); Heinloth, K.; Hoehne, K.; (and others). Nucl. Phys.; B38: No. 1, 1-19(1972).

The electroproduction of transversely polarized ρ^0-mesons on protons was measured detecting the scattered electron and the two decay π-mesons in spark-chamber spectrometers. The differential cross sections $d\sigma_u/dt$ and $d\sigma_u/d(t-t_{min})$ were determined as functions of W, q^2 and t and W, q^2 and $t-t_{min}$ in the kinematical region $2.60 \leq W \leq 2.95$ GeV, $-0.12 \geq q^2 \geq -0.40$ GeV^2/c^2, $t_{min} \geq t \geq -0.15$ GeV^2/c^2. (auth)

21363 NEW IDEAS AND TECHNIQUES FOR HYPERON MAGNETIC MOMENT MEASUREMENT. Barkov, L. M.; Zolotorev, M. S.; Okhapkin, V. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 603-12 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The experimental measurement of the magnetic moment of Σ^+ hyperons as generated by γ quanta on solid hydrogen targets is described. A beam of 1.35-GeV electrons from an accelerator was delivered as a 1 mm^2 cluster in 2 ns to a tungsten converter and converted to a narrow bremsstrahlung beam. This beam was passed through a magnetic field to separate electrons and then encountered a solid hydrogen target where the photoproduction of Σ^+ hyperons occurred. Measurement of the magnetic field by two methods is described. The accuracy of the hyperon magnetic moment measurement by a photoemulsion detector was determined by the number of recorded hyperon disintegrations and the size of the angle of rotation of hyperon spin in the magnetic field. (K.S.W.)

Weak

Refer also to abstracts 20437, 20456, 20460, 20462, 20471, 21000, 21238, and 21299.

21364 (LBL-550) MEASUREMENT OF THE CHARGE ASYMMETRY IN THE DECAY $K_L^0 \rightarrow \pi\mu\nu$. McCarthy, Robert Lane (California Univ., Berkeley. Lawrence Berkeley Lab.). Nov. 1971. Contract W-7405-eng-48. 169p. Dep. NTIS.

Thesis.

If $\Gamma_\pm$ = Rate $(K_L^0 \rightarrow \pi^\mp\mu^\pm\nu)$, the $K_{\mu 3}^0$ charge asymmetry is defined to be $\delta = (\Gamma_+ - \Gamma_-)/(\Gamma_+ + \Gamma_-)$. This number was measured to be $(2.1 \pm 1.0) \times 10^{-3}$ at the Lawrence Berkeley Laboratory's Bevatron. The error is meant to be interpreted as one standard deviation and contains both a statistical and a systematic contribution. The systematic contribution is a measure of the accuracy with which a neutron-induced background was excluded. (auth)

21365 STATUS OF SEARCH FOR $\bar{\nu}_e + e^- \rightarrow \bar{\nu}_e + e^-$. Reines, F. (Univ. of California, Irvine). pp 236-42 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

The present status of a search for the process $\bar{\nu}_e + e^- \rightarrow \bar{\nu}_e + e^-$ being conducted at a Savannah River Plant fission reactor is described. The detector used consists of an 8 kilogram plastic scintillator target surrounded by a 330 kilogram NaI detector. The results are summarized along with predictions from the V-A theory. An improved experiment using a modified composite plastic–NaI detector is briefly described. (L.B.S.)

Strong (Baryon-induced)

Refer also to abstracts 20438, 20451, 21027, and 21037.

21366 (LUIP-CR-71-6) NUCLEAR DISINTEGRATIONS PRODUCED BY MULTIPLY CHARGED PARTICLES. Kullberg, R.; Otterlund, I.; Resman, R. (Lund Univ. (Sweden). Dept. of Physics). Sep 1971. 46p. Dep. NTIS (U. S. Sales Only).

Nucleus–nucleus collisions produced in nuclear emulsions by heavy cosmic ray primaries were analysed. The kinetic energy of the incident nuclei are larger than 100 MeV/nucleon. The angular and energy distributions of protons with energies <10 MeV and alpha-particles with energies <200 MeV were studied. Low-energy protons and alpha particles are emitted isotropically in a system moving with a mean velocity component in the forward direction of 0.02 c. It is found that there is an excess of low-energy protons which cannot be explained without using extremely low values of the Coulomb barrier. It is also found that evaporation theory cannot account for all the alpha-particles. In high-energy nucleus–nucleus interactions alpha-particles are produced partly by emission from disintegrating fragments and partly by a knock-on process in which quasi-elastic collisions between nucleons and alpha-clusters take place. This last statement is supported by the fact that alpha particles are emitted with high momentum components in the forward as well as in the transverse direction. (auth) (Sweden)

21367 TIME STRUCTURE OF THE HADRONIC COMPONENT OF EXTENSIVE AIR SHOWERS. Tonwar, S. C.; Murthy, G. T.; Sreekantan, B. V. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A; 74: No. 5, 203-29 (Nov 1971).

A detailed study of the time structure of hadrons of energy >5 GeV in extensive air showers was carried out at Ootacamund (8.00 gm/cm^2) using a total absorption spectrometer at the center of the T.I.F.R. air shower array. A comparison of the experimental results with theoretical calculations shows that the experimentally observed spectra can be explained only on the basis of a rather large production (~15%) of nucleon-antinucleon pairs among the secondaries of high energy interactions. Also it was shown that an isobar-cum-pionization type of model is preferred to a pure pionization model in ultra high energy interactions. A small fraction of hadrons (~0.5%) of energy >20 GeV are found to arrive considerably delayed (>25 ns) with respect to the shower front. While these are indicative of the presence of heavy mass particles ($M \sim 10$ GeV/c^2) among the hadrons in air showers it is concluded that experiments of a more direct nature are essential for establishing the production of heavy mass particles. All the details regarding the experimental set up, the procedures for classification and analysis of data and the methods adopted for the evaluation of the errors in the measurement of energy and time delay are presented and the main conclusions from the experimental results summarized. Details of calculations of the time structure functions on the basis of different models of high energy interactions and a critical discussion of the comparison of the experimental results with theoretical predictions are presented elsewhere. (auth)

21368 BREMSSTRAHLUNG IN $\alpha-\alpha$ SCATTERING AT 9.35 MeV. Frois, B.; Birchall, J.; Roy, R.; Slobodrian, R. J. (Univ. Laval, Quebec). Phys. Rev. Lett.; 28: No. 10, 633-6(6 Mar 1972).

A measurement of the $\alpha-\alpha$ bremsstrahlung cross section at 9.35 MeV has established the upper limit 5.1 μb/sr^2 with 90% probability. A comparison with predictions, including only single-scattering terms, is given. (auth)

21369 SINGLE PARTICLE DISTRIBUTIONS OF PIONS FROM $\bar{p}p$ ANNIHILATION AT 2.32 GeV/c. Hoang, T. F. (Argonne National Lab., Ill.); Yen, E.; Rhines, D.; Cooper, W. A. Nucl. Phys.; B38: No. 1, 62-86(1972).

An analysis of single particle distributions of π mesons from a high statistics $\bar{p}p$ annihilation at 2.32 GeV/c is presented. It was found that in the reactions $\bar{p}p \rightarrow n\pi$ with n = 4, 5, 6, and 7, the gross features of the c.m. longitudinal and the transverse momentum distributions follow close to the phase space. The c.m. longitudinal momentum distributions show an asymmetry, which is characteristic of the disfavored fragmentation postulated by Chou and Yang. The magnitude of the asymmetry is found to decrease with the multiplicity n. A comparison between the experimental distributions and those computed from the multiperipheral model of Chan, Loskiewicz and Allison is presented. An inclusive single particle distribution for π^+ and a fit with the form $(1-x)^c$ for the Feynman variable $x > 0.68$ is presented. (auth)

21370 INELASTIC PROTON–PROTON SCATTERING AT VERY HIGH ENERGY. Ratner, L. G. (Argonne National Lab., Ill.); Ellis, R. J.; Vannini, G.; (and others). pp 99-105 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

Data on inclusive cross sections for $p + p \rightarrow \pi^+ +$ anything and $p + p \rightarrow p +$ anything at 500 to 1500 GeV from an experiment on the CERN intersecting storage rings are presented along with a brief discussion. (L.B.S.)

21371 OBSERVATION OF HIGH ENERGY PIONS IN INTERACTIONS OF RELATIVISTIC DEUTERONS WITH NUCLEI. Baldin, A. M.; Ghiordanescu, N.; Kirillov, A. D.; (and others) (Joint Inst. of Nuclear Research, Dubna, USSR). pp 131-9 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

The production cross sections of negative pions by relativistic deuterium nuclei were measured. The energy of secondary pions exceeded the kinematic boundary of the pion production by a single nucleon from deuteron. It has been obtained that the ratio of the differential cross sections of the pion production by deuterons and protons, at the angle 0°, $(d^2\sigma_d/d\Omega dp)/(d^2\sigma_p/d\Omega dp)$ at equal P/P_{max} is 0.05 and, within the limits of errors, does not depend on the energy of incident particles and pions produced. (auth)

Strong (Meson-induced)

Refer also to abstracts 20445 and 20457.

21372 (CEA-R-4267) REACTIONS WITH THREE OUTGOING PARTICLES IN $\pi^\pm$p COLLISIONS AT 11 GeV/c. Lewin, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 137p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, Orsay, France.

Two samples of 200,000 pictures obtained in a hydrogen bubble chamber were used to study the following reactions $\pi^\pm p \rightarrow p\pi^\pm\pi^0$ and $\pi^\pm p \rightarrow n\pi^+\pi^-$ at 11 GeV/c. The quasi two bodies channels $\pi^+p \rightarrow \pi^0\Delta^{++}$ (1236), $\pi^-p \rightarrow np^0$(765) and $\pi^\pm p \rightarrow pp^\pm$(765) were examined. The Regge pole model was compared with data obtained for the channel $\pi^+p \rightarrow \pi^0\Delta^{++}$. (France)

21373 (FRNC-TH-137) DEPENDENCE ON U OF THE DIFFERENTIAL CROSS SECTION IN 6 GeV/c BACKWARD ELASTIC PION–PROTON SCATTERING. Gonidec, Allain (Paris Univ. (France). Faculte des Sciences). 1971. 52p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The variations in the differential cross section for backward elastic pion proton scattering at 6 GeV/c were studied as a function of the square of the transfer momentum(U). The principles of the experiment are as follows: a pion beam hits a polarized proton target; the scattered pions are detected in coincidence with the recoil proton for the two directions of polarization of the target. The trajectories were reconstructed from information provided by hodoscopes. A kinematic calculation enabled the events to be selected and classified in every U channel. The experimental equipment, the data acquisition system, and the reconstruction of events system are described. The results obtained are compared with those predicted in the framework of the Regge pole model. (France)

21374 REAL PART OF THE NUCLEUS–K^- MESON POTENTIAL AT 800 MeV/c. Dellagi, Mohamed (Univ., Tunis). Compt. Rend., Ser. B; 273: No. 23, 1051-3(8 Dec 1971). (In French).

K^- mesons are recorded parallel to the plane of a nuclear plate. The experimental distribution corresponding to variations in the angle θ is considered, θ being the projected angle in the plane of the plate corresponding to the K^- nucleus scattering in the emulsion. The real part of the nucleus-K^- potential corresponding to a nuclear radius of R and a charge Ze is postulated to have the form $N(r) = \gamma(Ze^2/R)\exp(-r/R)$, where r is the distance between K^- and the center of the nucleus and γ is a coefficient found to be 0.90 ± 0.07. The respective values of N(0) for light and heavy nuclei are 3.1 and 8.5 MeV. (France)

21375 DETERMINATION OF PION–NUCLEON SCATTERING AMPLITUDES FROM EXPERIMENTAL DATA. Giffon, Maurice; Laverriere, Roger (Univ. Lyon, Villeurbanne, France). Compt. Rend., Ser. B; 273: No. 21, 893-5(22 Nov 1971). (In French).

An algebraic expression was deduced from recent measurements of the rotation parameters $R^\pm$ involved in $\pi^\pm$ proton elastic scattering for the different amplitudes. (France)

21376 COMPARISON OF A_1–A_2 INTERFERENCE BETWEEN π^-p AND π^+p REACTION AT 5 GeV/c. Werbrouck, A. E. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin); Rinaudo, G.; Bossen, G. J.; (and others). Lett. Nuovo Cim.; 3: No. 4, 141-6 (22 Jan 1972).

The interference terms between A_1 and A_2 of the $\pi^-p \rightarrow \pi^-\rho^0p$ are compared with those of the $\pi^+p \rightarrow \pi^+\rho^0p$ interaction by analyzing the moments of the distributions of the three Euler angles which describe the 3π decay plane. It is found that the interference terms have the same sign in π^- and π^+ initiated reactions, which is attributed to the presence of a sizable isoscalar-exchange contribution in A_2 production. (L.B.S.)

21377 FINAL STATES WITH A VISIBLE Λ-HYPERON IN K^-d INTERACTIONS AT 3.4 GeV/c. Eckert, R. R.; Kwak, N.; Nicholas, M.; Stump, R. (Univ. of Kansas, Lawrence). Nuovo Cim.; 8A: No. 1, 173-95(1 Mar 1972).

The final states with a Λ-hyperon produced by 3.4 GeV/c K^--mesons on deuterium were studied. The main feature of the reactions is copious production of the $\Sigma(1385)$, $\rho(765)$ and $\omega(783)$ resonances. The nonvanishing polarizations of the Λ-hyperons in the $\Lambda\pi^-$ channel disagree with the strong form of exchange degeneracy of the Regge picture. A $\pi^-\pi^-$ enhancement at about 850 MeV was observed, however it requires further study. (auth)

21378 ELASTIC BACKWARD SCATTERING OF NEGATIVE PIONS ON NEUTRONS AT 23 AND 40 GeV/c. Babaev, A.; Brakhman, E.; Eliseev, G.; (and others) (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 38B: No. 5, 342-4 (6 Mar 1972).

The differential cross sections of the elastic backward scattering reaction $\pi^- n \to n\pi^-$ were measured at 23 and 40 GeV/c in the u-interval $-0.07 \leq u \leq 0.01$ $(GeV/c)^2$. (auth)

21379 MEASUREMENTS OF $\rho-\omega$ INTERFERENCE IN THE REACTION $\pi^- p \to \pi^+\pi^- n$ at 15 GeV/c. Ratcliff, B. N.; Bulos, F.; Carnegie, R. K.; (and others) (Stanford Univ., Calif.). Phys. Lett.; 38B: No. 5, 345-8(6 Mar 1972).

In a study of the reaction $\pi^- p \to \pi^+\pi^- n$ at 15 GeV/c pronounced $\rho-\omega$ interference effects between the transverse helicity states of the vector mesons were observed. The relative phase of the interfering amplitudes is determined to be -1.40 ± 0.45 rad, and the branching ratio $\omega \to 2\pi$ is found to be $2.1 + 2.8, -0.9\%$. (auth)

21380 STRANGE PARTICLE PRODUCTION IN π^-p INTERACTIONS AT 1.69 GeV/c. Thomas, David William. Pittsburgh; Carnegie-Mellon Univ. (1972). 179p. University Microfilms Order No. 72-8073.

Thesis.

Strange particle production is studied in π^-p interactions at 1.7 GeV/c. The center of mass energy is below threshold for production of K*(890)Σ, and the $Y_0^*(1405)$, $Y_0^*(1385)^0$ and $Y_1^*(1385)^-$ are observed with high statistical precision and low background. The mass, width, spin, and parity of each resonance are measured. The $Y_0^*(1405)$ data are used to test effective range and zero effective range models using the parameterizations of Kim and of Martin and Sakitt. The data are consistent with interpretation of the $Y_0^*(1405)$ as a $\bar{K}N$ bound state. The branching ratio of $Y_1^*(1385)$ is measured as $8 \pm 4\%$. Two body and quasi-two body production processes are parameterized in terms of partial wave amplitudes. The production distributions are found to be qualitatively consistent with the simple exchange model, and the production of $Y_0^*(1385)^0$ is in quantitative agreement with the ρ-photon model. Precision measurements are made of the lifetimes of the Σ^- and of the Λ. (Diss. Abstr. Int., B)

21381 CORRELATIONS IN THE TWO-PARTICLE INCLUSIVE REACTIONS $\pi^- + p \to \pi^- + \pi^- +$ ANYTHING. Shephard, W. D.; Powers, J. T.; Biswas, N. N.; (and others) (Univ. of Notre Dame, Ind.). Phys. Rev. Lett.; 28: No. 11, 703-5(13 Mar 1972).

Rapidity distributions for the one- and two-particle inclusive reactions $\pi^- + p \to \pi^-$ + anything and $\pi^- + p \to \pi^- + \pi^-$ + anything at 8 and 18.5 GeV/c, and $\pi^+ + p \to \pi^-$ + anything and $\pi^+ + p \to \pi^- + \pi^-$ + anything at 18.5 GeV c are presented. The two-particle correlation functions for these reactions are observed to show strong dependence on the rapidities of the final-state particles and on the nature and momentum of the incident particle. Systematic variations in these correlation functions are discussed. (auth)

21382 STUDY OF FOUR-PRONG EVENTS IN π^+p INTERACTIONS AT 3.5 GeV/c. Ronat, E. E.; Eisenberg, Y.; Lyons, L.; (and others). (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; B38: No. 1, 20-36(1972).

The non-strange four-prong events of π^+p interactions at 3.5 GeV/c are studied. Cross sections are calculated for all resonance productions in the channels $\pi^+ p \to p\pi^+\pi^+\pi^-$ ($\sigma_T = 3.18 \pm 0.13$ mb) and $\pi^+ p \to p\pi^+\pi^+\pi^-\pi^0$ ($\sigma_T = 4.03 \pm 0.16$ mb). The dominant two body reactions $\Delta^{++}\rho^0$ and $\Delta^{++}\omega^0$ are investigated in detail, and production and decay distributions are presented as well as joint decay density matrix elements and joint correlation terms. The $\Delta^{++}\rho^0$ reaction is compared to predictions of OPE with absorption and the $\Delta^{++}\omega^0$ is compared to rho-exchange with sharp cutoff. (auth)

21383 REACTIONS $K^- p \to Y^0$ + VECTOR MESON AT 3.15 AND 3.3 GeV/c, AND THE QUARK MODEL. Clark, A. G.; Lyons, L. (Nuclear Physics Lab., Oxford). Nucl. Phys.; B38: No. 1, 37-61(1972).

New data on the reactions $K^- p \to \Lambda\rho$, $\Sigma^0\rho$, $\Lambda\omega$, $\Lambda\phi$, $\Sigma^0\phi$, $Y^*\rho$ and $Y^*\phi$ are presented. All the reactions are characterised by forward-peaked production angular distributions. Fits of the form exp (At') to the momentum transfer distributions result in values of $A \sim 1$ $(GeV/c)^{-2}$. The decay distributions of the vector mesons are examined with respect to an axis normal to the production plane. The data are compared with the quark model predictions for the ρ/ω, Λ/Σ^0 and Λ/Y^* ratios. The most serious contradiction is for the Λ/Σ^0 ratio, which is experimentally too small. (auth)

21384 STUDY OF THE K$\pi\pi$ ENHANCEMENT IN THE Q REGION IN $K^- d \to K^-\pi^-\pi^+ np$ AT 7.3 GeV/c. Anderson, Kelby John. Boulder, Colo.; Univ. of Colorado (1971). 172p. University Microfilms Order No. 72-3617.

Thesis.

The reaction $K^- d \to K^-\pi^-\pi^+ np$, at 7.3 GeV/c is studied in a 52,000 frame exposure of the Brookhaven National Laboratory 80-inch bubble chamber. Production of the two-body resonances K*(890), K**(1420), ρ^0(765), Δ^-(1236), Δ^+(1236), and possibly N*(1510) with quasi-two-body final states K*(890)Δ^-(1236) and K**(1420)Δ^-(1236) are observed. Cross sections for the resonances are estimated. The Q enhancement in the low mass K$\pi\pi$ spectra and evidence for splitting into two resonance states $K_A(1250)$ and $K_A(1400)$ is observed. An off mass shell one-pion-exchange model calculation is made and it is found that the Q enhancement cannot be accounted for by kinematic reflection. K**π^- and K$^-\rho^0$ decay modes are observed with the K$^-\rho^0$ mode accounting for $13.5^{+11}_{-13}\%$ of $K_A(1250)$ and $13.9^{+11}_{-13}\%$ of $K_A(1400)$. Analyses of the spin and parity are made. Statistics are small and a definite determination is not possible but both resonances are consistent with 1^+ and 2^-. (Diss. Abstr. Int., B)

21385 MEASUREMENT OF PI(MINUS)–PROTON TO NEUTRON–GAMMA DIFFERENTIAL CROSS SECTION AT 370 AND 332 MeV. Berardo, Peter Antonio. Los Angeles; Univ. of California (1971). 158p. University Microfilms Order No. 72-2777.

Thesis.

Measurements were made of the differential cross section for $\pi^- p \to n\gamma$ at six angles and pion laboratory kinetic energies of 370 and 332 MeV. The data does not agree with recent theoretical predictions. There is no evidence, in the sense suggested by Donnachie, for the classification of the Roper, $P_{11}(1470)$ resonance in an SU(3) antidecuplet. The angular distributions are consistent with the classification of the Roper resonance in an octet, as predicted by simple quark models. Using detailed balance, the results agree with the reported cross sections for the inverse reaction, which are deduced from πd data. (Diss. Abstr. Int., B)

21386 TWO PION FINAL STATES IN π^+d INTERACTIONS AT 7 GeV/c. Carroll, John Terrance. Madison, Wis.; Univ. of Wisconsin (1971). 213p. University Microfilms Order No. 71-28,982.

Thesis.

The reactions $\pi^+ d \to p_s p$ + neutrals and $\pi^+ d \to p_s p\pi^+\pi^-$ were studied at an incident π^+ beam momentum of 7 GeV/c. The data was obtained in a 650,000 picture exposure of the Argonne 30" deuterium filled bubble chamber. Two $\frac{1}{8}$" tantalum plates mounted in the chamber allowed reconstruction of $\pi^+ d \to p_s p\pi^0\pi^0$ using the converted gammas from the π^0 decay. In the $2\pi^0$ mass spectrum and angular distributions a strong f^0 signal was observed. Using the OPE model $\sigma(\pi^+\pi^- \to \pi^0\pi^0)$ was found near the S-wave unitarity limit for $0.6 < M\text{-}(\pi^0\pi^0) < 0.9$ GeV/c. The results favor the "up-down" solution for S-wave $\pi\pi$ scattering in the ρ mass region. In $M(\pi^+\pi^-)$ ρ^0, f^0, and g^0 resonance production were observed. The 4-prong data shows evidence for constructive $\rho-\omega$ interference. The data from this experiment was combined with data from a study of $\pi^- p \to n\pi^+\pi^-$ at 7 GeV c to obtain a total sample of 10,845 $\pi^+\pi^-$ events. From this compilation $\pi\pi$ phase shifts were obtained for $0.6 < M(\pi\pi) < 1.5$ GeV/c using an absorption modified one-pion-exchange model. An anomaly in the $\pi\pi$ angular distributions in the 1.0 –1.2 GeV/c^2 region appears to be a P–D wave interference effect. It was found that the I = 0 S-wave rises through 90° in the f^0 peak region. From an examination of non-2π f^0 decay modes $\eta_D^0 \simeq .83$ was estimated at the f^0 peak. Evidence is presented for an A_2 exchange contribution to ρ^0 production. (Diss. Abstr. Int., B)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 21512.

21387 (COO-3130-TA-257) CORRELATION LENGTHS, INCLUSIVE TRANSVERSE MOMENTUM DISTRIBUTIONS AND MULTIPERIPHERALISM. Mak, Se-Yuen; Tan, Chung-I (Brown Univ., Providence, R. I. Dept. of Physics). [1971]. 46p. Dep. NTIS.

Transverse momentum distributions in the pionization region of the single- and two-particle inclusive reactions are studied using both the general multiperipheral considerations and a specific multi-Regge model with exponential damping in momen-

tum transfers. The slope of the diffractive peak for elastic scattering is shown to set the scale for the inclusive transverse momentum distributions. The same reasonings also lead to a "broadening" of $\langle q_1^2 \rangle$ and to a peaking effect at $\cos\phi = -1$ for the single- and two-particle distributions respectively. The latter correlation effect is due to the existence of a J-plane branch point, thus having a correlation length $(\alpha_v - \alpha_c)^{-1}$. These general results are then verified by calculations based on an explicit multi-Regge model. Possible corrections to these results are also discussed. (auth)

21388 POSSIBLE ROLE OF ELEMENTARY PARTICLE PHYSICS IN COSMOLOGY. Omnes, R. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Rep.; 3C: No. 1, 1-55(Feb 1972).

This is a review which is concerned with the following topics: the thermodynamical behavior of a system of particles at ultra-high temperatures, including Hagedorn's suggestion for the existence of an absolute upper limit to the temperature together with the discussion of phase transitions which could lead to particle–antiparticle separation, the astrophysical consequences of these effects in the framework of an evolutionary isotropic universe and their relevance to the problems of the origin of matter and galaxies. (auth)

21389 SUBNUCLEONIC PARTICLES AND THEIR INTERACTIONS AT RELATIVISTIC ENERGIES. Wataghin, Gleb. Atti Accad. Sci. Torino, I, Cl. Sci. Fis., Mat. Natur.; 105: No. 5-6, 765-8(Sep-Dec 1971). (In Italian).

Some properties of sub-nucleonic constituent of "elementary particles" are examined. It is pointed out that in accord with the nonlocal theory proposed these sub-nucleonic components must have an extension in the 3-dimensional space and a finite life-time. (auth)

21390 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 3, 1972. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 73p.

21391 EQUAL TIME COMMUTATORS AMONG GENERATORS FOR BROKEN CONFORMAL AND INTERNAL SYMMETRIES. Gatto, R.; Sartori, G. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim.; 8A: No. 1, 215-16 (1 Mar 1972).

An addendum to a previous paper (Nuovo Cimento, 7A, 99(1972)) clarifies the plausibility of the assumption made that the equal time commutator between D^0 and θ does not contain Schwinger terms of order ≥ 2, $D^0(x)$ is the divergence of the current and $\theta(x)$ is the trace of the energy momentum tensor. (L.B.S.)

21392 SEMINAR DE FIZICA TEORETICA. 4. (Seminar on Theoretical Physics. IV). Novacu, V. Bucharest; Editura Academiei Republicii Socialiste Romania (1971). 196p.

Solid state and elementary particle theory are discussed. The theory of solid state covers polarons, vertex part method for study of collective excitation and instabilities of Fermi systems, and the Green function approach to the study of disordered systems. Elementary particle theory covers the parton model, electromagnetic form factors, and vector dominance model tests in photoproduction. (J.F.P.)

21393 INTERACTION OF HIGH-ENERGY RADIATION WITH MATTER. Barashenkov, V. S.; Sobolevskii, N. M.; Toneev, V. D. At. Energ. (USSR); 32: No. 2, 123-9(Feb 1972). (In Russian).

On the basis of the cascade-evaporation model of nuclear reactions, a statistical (Monte-Carlo) method was developed for calculating the interactions with matter of particles having energies from tens of MeV to tens of GeV. The ionization losses, meson-production processes and π-meson decay are taken into account. The propagation of low-energy neutrons is described by means of a multigroup system of constants used in designing nuclear reactors. The method is applicable for blocks of matter of practically any composition and configuration. The calculated results are compared with the available experimental data and the published calculations of other authors. (7 figures, 14 references.) (auth)

21394 ONE-BOSON LEE MODEL AND STATISTICAL-MECHANICAL TRANSFORMATION THEORY. Davidson, R.; Rae, J. (Center for Statistical Mechanics and Thermodynamics, Austin, Tex.). Bull. Cl. Sci., Acad. Roy. Belg.; 57: No. 3, 325-37(1971).

The superoperator transformation theory developed by the Brussels school is applied to a simple quantum-mechanical system: the one-boson Lee model. The existence of a diagonalizing transformation for this model permits the solution of dynamical problems such as that of induced emission and the construction of explicit matrix representations for asymptotic and dressing operators of the theory. (auth)

21395 THREE-BODY PROBLEM IN QUANTUM MECHANICS. Sasakawa, Tatuya (Tohoku Univ., Sendai). Nippon Butsuri Gakkaishi; 26: No. 9, 658-73(Sep 1971). (In Japanese).

Three body problem in quantum mechanics was developed to check the two body force by applying it to calculation of the binding energy among three particles. Since the proposal by Faddeev of so called Faddeev's equation, many papers were published concerning the three body problem with separable potential such as the Yamaguchi potential. Calculation with a local potential, however, is still in question. The present status of the three body problem is explained. Assuming forces among three particles as two body forces, the transition matrix T is given by Lippmann–Schwinger's equation. Some condition is necessary to solve the equation, and the integral kernel under the condition is called the square integrable kernel, L^2-integral kernel, or compact kernel. Faddeev showed the possibility of a method to solve the equation. It was found that the equation given by Faddeev can be solved according to Fredholm's theory. On the other hand, Weinberg introduced an equation different from the Faddeev's equation. The solution of the Weinberg's equation can be in a spurious state. The condition which causes the spurious state was investigated by Kazaks and Greider. They showed equations having a compact kernel but no spurious state. Effective methods to solve the three body problem are to use the separable potential, the separable transition matrix, and to use theory of symmetrical kernel. Calculation by the Yamaguchi potential is explained as an example of the separable potential. It is also shown that the three body problem can be solved by using an eigenfunction of the integral symmetrical kernel, and reducing it to one dimensional simultaneous integral equations. Future applications of the three body problem are the development to the many body problem, more precise calculation of the three body problem, and application to practical problems. (Japan)

21396 INVITED PAPERS. Lectures from the Conference on Fundamental Interactions at High Energy, Coral Gables, Florida, January 20–22, 1971. Dal Cin, Mario; Iverson, Geoffrey J.; Perlmutter, Arnold (eds.). Tracts in Mathematics and Natural Sciences. Volume 3. New York; Gordon and Breach, Science Publishers, Inc. (1971). 165p. (CONF-710106-(Vol.3)).

Abstracts were prepared for three of the five included lectures. Two lectures were previously abstracted for NSA and appeared as CONF-710106-1 and -6. (L.B.S.)

For abstracts of individual lectures see: 21029, 21432, and 21526.

21397 ACAUSALITY AND OTHER DEFECTS OF EQUATIONS FOR INTERACTING HIGHER SPIN PARTICLES. Velo, Giorgio (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna); Zwanziger, Daniel. pp 8-22 of Troubles in the External Field Problem for Invariant Wave Equations. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

A general review is given of efforts to find satisfactory equations for massive interacting particles of arbitrary spin, indicating the kind of difficulties encountered. The classical field equations are analyzed, based primarily on the method of characteristics of partial differential equations. This nonperturbative method shows that the solutions to familiar higher spin equations propagate acausally, whereas the perturbative solution is causal in every order. (L.B.S.)

21398 LIGHT CONE IN PARTICLE PHYSICS. Brandt, Richard A. (New York Univ., N. Y.); Preparata, Giuliano. pp 43-60 of Broken Scale Invariance and the Light Cone. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

A review is given of some recent developments in the application of light cone expansions in particle physics. A completely general argument is presented for the relevance of the light cone to the description of a large class of processes. The light cone operator product expansions are discussed. Information obtained from SLAC deep inelastic electroproduction experiments is reviewed. The importance of mass dispersion relations is discussed. Finally, some applications of the formalism are summarized. (L.B.S.)

21399 INCLUSIVE REACTIONS. Quigg, C. (State Univ. of New York, Stony Brook). pp 40-70 of Particles and Fields,

1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

After a brief discussion of the general features and kinematics of inclusive processes, a review is given of recent work in the study of inclusive reactions. Special emphasis is placed on the applications of Regge phenomenology suggested by Mueller's optical theorem analog for single-particle spectra. (auth)

21400 MULTIPARTICLE PROCESSES AT HIGH ENERGY. Bjorken, J. D. (Stanford Univ., Calif.). pp 110-23 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

Unlike the study of two-body scattering processes, analysis of multiparticle phenomena will always involve a subjective element: the selection from a vast amount of primary data of some small subsample comprehensible to the human mind. Therefore diverse methods of viewing the primary data are of crucial importance. In pursuit of this goal light-cone variables and rapidity are suggested as useful variables, and the use of 3-dimensional models for analyses is suggested for multibody events. A possible analog to statistical mechanics and the theory of liquids invented by Feynman and formally developed by Mueller which may be applicable to multiparticle phenomenology is also discussed. (auth)

21401 CURRENT PROBLEMS IN HIGH ENERGY PHYSICS. Samios, N. P. (Brookhaven National Lab., Upton, N. Y.). pp 140-50 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

Some current problems discussed are: the search for actual quark particles; the search for exotic resonances; the Ξ states in SU(3); baryons in SU(6) multiplets; search for the intermediate vector boson; the existence of self-class currents; and the $K_L^0 \rightarrow \mu^+\mu^-$ decay. (L.B.S.)

21402 REMARKS ON INELASTIC PROCESSES WITH LOGARIGHMICALLY INCREASING RADIUS OF INTERACTION. Kaidalov, A. B.; Okun, L. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 4, 886-7(Oct 1971). (In Russian).

If Pomeranchuk's equality is violated, the total cross sections of particle/antiparticle interactions with a given target are constant and not equal to each other, and the radius of interaction = ln s. The difference with respect to imaginary parts of given particle/antiparticle scattering amplitudes alternate similar to the functions of their arguments. The distinction discussed may not be associated with some class of nonelastic processes in which interaction occurs at great distances. Thus, if a violation of Pomeranchuk's equation occurs, it may be caused by inelastic processes with the formation of particles possessing the calculated masses, but only in the event that the state does not possess a fixed value or may change inner quantum numbers, such as charge, unitarity, or isospin. (K.S.W.)

Electromagnetic

Refer also to abstracts 20987, 22066, and 22152.

21403 (LA-4824, pp 83-6) MONITORING OF STOPPING PION BEAMS. Ziock, K. O. H. (Virginia Univ., Charlottesville. Dept. of Physics). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

The determination of the energy of an incoming beam of negative pions that will, after slowing down in a moderator, lead to the highest number of stopping pions per unit range interval is discussed. A Monte Carlo program to determine this value is outlined. Range curves are presented for 25-, 50-, 75-, 100-, 125-, and 150-MeV pions in carbon. The number of stopping particles for a normalized input beam as a function of beam energy, the expected intensity of the negative pion beam from the LAMPF low-energy pion beam as a function of energy, and the stopping intensity that can be expected for various beam energies are also shown. It is concluded that 50 MeV is the preferred energy. (7 figures) (R.W.R.)

21404 (N-71-15178) ON THE MOTION AND RADIATION OF CHARGED PARTICLES IN STRONG ELECTROMAGNETIC WAVES. 1. MOTION IN PLANE AND SPHERICAL WAVES. Gunn, James E. (Hale Observatories, Pasadena, Calif.); Ostriker, Jeremiah P. (California Inst. of Tech., Pasadena). Oct 1970. Contracts AF49(638)-1555; NONR-220(47). 47p. (NASA-CR-111535; OAP-221). NTIS.

The motion of test particles is studied in strong electromagnetic waves considering both plane and spherical wavefronts, both with and without radiative reaction. Various limiting cases are discussed. Initially low-energy particles dropped into a strong plane wave are accelerated in the propagation direction up to an energy porportional to B to the 2nd power while oscillating with a transverse energy proportional to B. In spherical waves particles injected very close to the source become phase locked with the driving wave and are accelerated in the manner described in earlier work; particles injected further out follow orbits like classical particles in a repulsive inverse cube force-field except that, for certain classes of initial conditions, an essentially random energy redistribution (of limited range) is possible. (STAR)

21405 (NYO-4076-16) "NUCLEAR PHYSICS" OF NUCLEONS (RESONANCE MODEL OF INELASTIC ELECTRON AND NEUTRINO SCATTERING). Domokos, Gabor; Domokos, S. Kovesi (National Accelerator Lab., Batavia, Ill. Johns Hopkins Univ., Baltimore, Md. Dept. of Physics); Schonberg, E. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Jun 1971. Contract AT(30-1)-4076. 23p. (CONF-710816-6). Dep. NTIS.

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

The physical aspects of a resonance dominance model of inelastic electron and neutrino scattering are discussed, and its main predictions summarized. Analogies with the electroexcitation of nuclei are stressed, and possible relations with the quark-parton models are discussed. The possibility of a breakdown of scaling as a consequence of changes in the form of the baryon spectrum is investigated, and a way of testing it experimentally is suggested. (auth)

21406 FIELD-THEORETIC REGGEIZATION IN FIVE- AND SIX-POINT FUNCTIONS. Balakrishnan, B. (Massachusetts Inst. of Tech., Cambridge. State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 4, 1142-50(15 Aug 1971).

Multiparticle S-matrix elements of the type $N\gamma \rightarrow N\gamma\gamma$, $N\gamma\gamma \rightarrow N\gamma\gamma$ are calculated in the tree approximation, in a field theory of spin-½ "nucleons" (N) and spin-1 massive "photons" (γ) coupled to the conserved nucleon current. After projecting out the positive-parity amplitude, the asymptotic behavior is found to be consistent with a Reggeized nucleon. The double-Regge-pole limit of $N\gamma \rightarrow N\gamma\gamma$ also indicates a Reggeized nucleon, and the residues factor. The method can be extended to S-matrix elements with arbitrary numbers of photons. (auth)

21407 REGGE POLES WITH KINEMATIC CUTS IN PION PHOTOPRODUCTION. Kim Yong Taik; Pfeil, W. (Univ., Bonn). Nuovo Cim.; 8A: No. 1, 119-28(1 Mar 1972).

Backward pion photoproduction is investigated with the Regge-pole model, including kinematic cuts to remove parity doublets. A satisfactory fit of the data is obtained, but no unique set of parameters can be found by the available differential cross section data. (auth)

21408 EMISSION BY A CHARGE MOVING IN A MEDIUM IN THE FIELD OF AN INTENSE WAVE. Dement'ev, A. S.; Kul'kin, A. G.; Pavlenko, Yu. G. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 62: No. 1, 161-6(Jan 1972). (In Russian).

The law of motion of a charge moving in an isotropic, transparent medium in the field of an intense electromagnetic wave is found. The dependence of intensity of Cherenkov radiation and normal and anomalous scattering cross sections on intensity of the incident circular polarized wave is investigated. (auth)

21409 SHOCK WAVE STRUCTURE IN THE RADIATION SPECTRUM DURING BOSE CONDENSATION OF PHOTONS. Zel'dovich, Ya. B.; Syunyaev, R. A. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 153-60 (Jan 1972). (In Russian).

The spectrum of photons interacting with electrons via the induced Compton effect is considered. Assuming weak energy transfer per collision it was previously predicted that a discontinuity may arise in the dependence of intensity on frequency ("shock wave" in phase space). It is shown that if the finite temperature of the electrons is taken into account, the slope of the spectrum increases only up to a certain limit after which an oscillatory dependence of intensity on frequency arises on the shortwave side of the spectrum. The structure of the "shock wave" is thus found to be more complex than previously assumed. It is similar to a collisionless wave in a plasma and not to a viscous wave in a neutral gas. (auth)

21410 W-MESON PAIR PRODUCTION IN HIGH ENERGY ELECTRON COLLISIONS. Ter-Isaakyan, N. L.; Khoze, V. A. (Inst. of Physics, Erevan). Zh. Eksp. Teor. Fiz.; 62: No. 1, 42-8(Jan 1972). (In Russian).

Total cross sections for $e^+ + e^- \rightarrow e^+ + e^- + W^+ + W^-$ processes are obtained in the asymptotic region of initial particle energies for cases when the anomalous magnetic moment of the W-meson is zero. The covariant formulation of the Weizsacker–Williams method whose validity is ensured by ultrarelativism of the electrons is employed. The asymptotic behavior of the $e^+ + e^- \rightarrow W^+ + W^- + \mu^+ + \mu^-$ cross section is found. (auth)

21411 SLOWING-DOWN OF THE DIRAC MONOPOLE IN METALS AND FERROMAGNETIC SUBSTANCES. Martem'yanov, V. P.; Khakimov, S. Kh. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 35-41(Jan 1972). (In Russian).

Estimates are made of slowing down of the Dirac monopole in metals and ferromagnets. It is shown that ferromagnetic substances in strong magnetic fields (~10^4 G) are effective traps for magnetic monopoles. (auth)

21412 DELTA-FUNCTION DERIVATIVES OF ARBITRARY ORDER IN EQUAL-TIME CHARGE CURRENT COMMUTATOR. Pradhan, T. (International Center for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 3: No. 8, 332-4(19 Feb 1972).

It is shown that delta-function derivatives of arbitrary order can exist in the one-electron expectation value of the equal-time charge current commutator for collision of unpolarized photons with electrons. (L.B.S.)

21413 LINEAR-RESPONSE THEORY FOR SYSTEMS PERFORMING A RANDOM WALK. Lakatos-Lindenberg, K.; Bedeaux, D. (Univ. of California, San Diego, La Jolla). Physica; 57: No. 2, 157-77(15 Jan 1972).

Linear response theory is developed for systems whose time dependence is described by a random walk equation. A fluctuation-dissipation theorem expressing the linear response of the system in terms of fluctuation properties of the system in equilibrium is derived. The results are illustrated by calculating the response of a charged particle which performs a random walk along a finite linear chain in a time-dependent external electric field. (auth)

21414 TRANSITION ACCELERATION OF A CHARGED PARTICLE PASSING THROUGH A BOUNDARY OF AN INVERTED DIELECTRIC. Gavrilov, V. P.; Kolomenskii, A. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 12, 431-3(20 Dec 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 11, 617-19(5 Dec 1971).

The possible inversion of the transition radiation arising when a particle passes through the boundary between a vacuum and a dielectric is discussed. It is shown that on crossing the boundary between the vacuum and an inverted dielectric the ordinary radiation losses can give way to a new effect in which energy is transferred to the particle. The effect is called transition acceleration. (J.F.P.)

21415 COMPARISON OF EXPERIMENTAL AND THEORETICAL PAIR CROSS SECTIONS NEAR THE THRESHOLD. Rama Rao, J.; Murty, M. Sriramachandra; Parthasaradhi, K. (Andhra Univ., Waltair, India). Indian J. Phys.; 44: No. 9, 516-18(Sep 1970).

The experimental cross sections for electron pair production from gamma reactions with nuclei at 1.007 to 2.754 MeV are compared with the theory of Overbo et al. (Phys. Rev., 175, 1978 (1968)). (J.F.P.)

21416 CYCLOTRON RESONANCE IN RADIATION PULSES. Leer, E. (Norwegian Inst. of Cosmic Physics, Oslo). Physica; 56: No. 1, 93-103(15 Nov 1971).

The motion of a charged relativistic test particle in an arbitrary pulse of electromagnetic radiation propagating along a uniform magnetostatic field (in vacuum) is investigated. The space-time velocity components are given as functions of the proper time, and it is shown that there exists a maximum for the perpendicular velocity component. For particles initially at rest this value is $1/\sqrt{2}$ (in velocity of light units). For a singly peaked pulse shape the motion is investigated in detail and for the case of resonance the radius of gyration, the increase of the energy and a perpendicular velocity component are plotted as functions of the distance along the magnetostatic field. For interesting experimental situations it is shown that the rate of energy loss is small compared to the energy gain, and that the radiation reaction force does not disturb the resonance between the motion in the magnetostatic field and in the field of the electromagnetic wave. (auth)

21417 ELECTROMAGNETIC COUPLINGS OF THE f AND σ MESONS. Kleinert, H. (Freie Univ., Berlin); Staunton, L. P.; Weisz, P. H. Nucl. Phys.; B38: No. 1, 87-103(1972)

Use is made of the Ward identities for the $\theta_{\mu\nu}$ V_ρ V_λ vertex and the assumptions of f and σ meson dominance of the stress energy momentum tensor $\theta_{\mu\nu}$, and of vector meson dominance of the electromagnetic currents V_ρ to present estimates for the electromagnetic couplings of the f and σ mesons. A comparison is made with results obtained by other methods. (auth)

21418 ANOMALOUS MAGNETIC MOMENT OF THE ELECTRON IN STOCHASTIC QUANTUM MECHANICS. Cetto, A. M.; de la Pena-Auerbach, L. (Univ. Nacional Autonomade de Mexico, Mexico City). Rev. Mex. Fis.; 20: No. 3, 191-201(1971).

The first-order terms of the electromagnetic potentials for an extended electron are introduced into the stochastic scheme of quantum mechanics; thus we derive in a simple and straightforward form the corresponding observable corrections, as, for example, the anomalous magnetic moment of the electron. The final results are expressed in terms of some structure parameters, whose value may be only estimated at present; also, effects arising from the quantization of the radiation field are excluded a priori by our use of classical electrodynamics. (auth)

21419 DO WEBER'S EXPERIMENTS REVEAL THE PHOTON REST MASS? Gertsenshtein, M. E. JETP Lett. (USSR) (Engl. Transl.); 14: No. 12, 427-8(20 Dec 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 11, 611-13(5 Dec 1971).

It is pointed out that an interpretation of the Weber experiment is not unambiguous and that it is possible to register in such an experiment longitudinal electromagnetic waves which exist if the rest mass of the photon differs from zero. (J.F.P.)

21420 DOMINANCE OF ELECTROMAGNETIC INTERACTIONS IN HADRONIC PROCESSES $pp \rightarrow p\Delta$ AND $pp \rightarrow \Delta\Delta$. Nicot, R.; Salin, Ph. (Faculte des Sciences, Bordeaux). Nucl. Phys.; B38: No. 1, 247-60(1972).

Because of their s and t dependence, electromagnetic interactions (one photon exchange) may dominate at high energy over strong interactions in all nondiffractive reactions without charge or hypercharge exchange. It is shown that this may be the case of $pp \rightarrow p\Delta^+$ and $pp \rightarrow \Delta^+\Delta^+$ at soon available energies, opening therefore a new domain of experimental investigations. (auth)

21421 SPIN–PARITY DETERMINATION OF $X^0(960)$ MESON IN THE ELECTROMAGNETIC PRODUCTION PROCESSES. Khoze, V. A.; Zaslavskii, A. N. (Erevan Physical Inst.). Nucl. Phys.; B38: No. 1, 261-8(1972).

The processes of the X^0 (960) electromagnetic production (photoproduction on helium and proton, in e^+e^- pair annihilation, etc.) as well as the X^0 (960) radiation decays ($X^0 \rightarrow \rho e^+e^-$, $X^0 \rightarrow \rho\gamma$ with polarized photons) are analyzed in detail with the purpose of determining the X^0 (960) spin. Experiments, allowing the distinction of $J^P = 2^-$ and 0^- hypotheses for X^0 (960) spin-parity, are suggested. (auth)

21422 ELECTROMAGNETIC PROTON FORM FACTORS. Bilen'kaya, S. I.; Kazarinov, Yu. M.; Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2225-30(Dec 1971). (In Russian).

Satisfactory descriptions of proton electromagnetic form factors are found by treating available data on elastic e–p- and μ–p-scattering cross sections in the range of squared transferred momentum values $0.012 \leq q^2 \leq 25$ $(GeV/c)^2$. The form factor dependence is represented as the sum of poles with varying pole positions and residues and also by the product of Γ-functions whose arguments are defined by the variable parameters of the ρ-trajectory. It is shown that at large q^2 values the form factors behave as q^{-4}. (auth)

21423 VACUUM POLARIZATION AND PHOTON SPLITTING IN AN INTENSE FIELD. Papanyan, V. O.; Ritus, V. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2231-41(Dec 1971). (In Russian).

Due to vacuum polarization splitting of a photon into two photons becomes possible in an intense electromagnetic field. The general structure of the polarization operator which describes the three-photon interaction in an intense crossed field is determined. Its concrete expression for real photons in terms of two invariant functions is found. These functions describe the spectrum and polarization of finite photons as depending on the initial photon energy and polarization. For an initial photon energy of 25 GeV and a field strength of 4.10^9 Oe the photon mean free path with respect to photon splitting is of the order of several centimeters. (auth)

21424 NONLINEAR THEORY OF SYNCHROTRON RADIATION OF TUBULAR ELECTRON FLUX IN A CYLINDRICAL WAVEGUIDE. Kovalev, I. S.; Kuraev, A. A.; Demidovich, E. M.; Shevchenko, F. G. (Minsk Radiotechnical Inst.). Dokl. Akad. Nauk BSSR; 15: No. 8, 692-5(Aug 1971). (In Russian).

Gyroresonance apparatus using synchrotron radiation may be utilized as a source of high power. Nonlinear theory and a method for optimization of the efficiency are applicable in studying the interaction of the apparatus. Analysis of such apparatus designed for a tubular electron beam and a cylindrical waveguide is based on the joint solution of the relativistic equation of the motion of an electron and the equation of waveguide excitation. Rosenbrock's method is used in solving the problem and to determine the optimum variant. High electron efficiency in the optimum variant ($\eta_\perp = 0.84$) suggests that the apparatus, from the energy point of view, possesses an important advantage over classical uhf devices. (tr-auth)

21425 INVESTIGATION OF ELECTROMAGNETIC PION FORM FACTORS BY THE METHOD OF DISPERSION RELATIONS. I. Shcherbin, Yu. P. Vestn. Leningrad. Univ., No. 10, Fiz., Khim.; No. 2, 7-13(May 1971). (In Russian).

Dispersion relations and dispersion sum rules, connecting the form-factor values in the time and space-like regions of momentum transferred squared, are considered on the basis of usual assumptions on the analytical properties of pion form factor. These relations are very convenient for the analysis of the available experimental information. The contribution to the dispersion relation due to possible complex zeroes is investigated, and the conditions of fulfillment of inequalities, corresponding to the lower boundary of the form factor in space-like region, have been defined more exactly. (auth)

21426 DEEP INELASTIC ELECTRO AND PHOTOPRODUCTION IN A SPECIFIC MULTI-REGGE MODEL. Blum, K. (Univ., Munich). Lett. Nuovo Cim.; 3: No. 9, 357-62(26 Feb 1972).

The absorption of virtual photons with momentum q by protons is just treated, requiring large spacelike q^2. An expression for the differential cross section is then derived using standard techniques. The unknown parameters are determined using experimental information. Predictions are then made for the differential cross sections and parameters for deep inelastic photoproduction as a test for the assumptions used in the model. (L.B.S.)

21427 THEORY OF μ^+-MESON DEPOLARIZATION DURING CHARGE EXCHANGE IN TRANSVERSE MAGNETIC FIELDS. Ivantier, I. G.; Smilga, V. P. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2176-84(Dec 1971). (In Russian).

A theory is developed for depolarization of positive muons during charge exchange (or formation of unstable muonium chemical compounds) in transverse fields. Relaxation of the electron spin in muonium is taken into account. Integral equations for depolarization are formulated and solved. An expression is derived for residual polarization and it is shown that on renormalization of the theory parameters it goes over to an expression for polarization involving a pure muonium depolarization mechanism. For all cases when the time dependence of polarization could be observed expressions were obtained and relevant analyses were carried out. The possibility of obtaining information from experiments in longitudinal and transverse fields is analyzed, and various control relations are obtained in a number of cases. (auth)

21428 RELATIVITY AND THE CLASSICAL ELECTRON. Zink, J. W. (Univ. of California, Livermore). Amer. J. Phys.; 39: No. 11, 1403-4(Nov 1971).

It is pointed out that the result given by the equation for the momentum of the charge of a moving spherical shell of charge (the classical electron) is not in conflict with special relativity theory. (J.F.P.)

21429 MISINTERPRETATION OF THE AHARONOV–BOHM EFFECT. Boyer, Timothy H. (City Coll., New York). Amer. J. Phys.; 40: No. 1, 56-9(Jan 1972).

It is pointed out that accounts in the literature sometimes misinterpret the Aharonov–Bohm effect, involving the shift in interference pattern for electrons passing a long solenoid. The quantum description and experimental verification of the effect are reviewed, and it is emphasized that both theory and experiment indicate that there is no deflection of the average momentum of the electrons passing the solenoid. There is no average force on the electrons due to the solenoid. It is remarked that the Aharonov–Bohm effect involves the shift of double-slit interference fringes which is independent of the quantum unit of action $\hbar$ and yet allows a natural classical limit. (auth)

21430 LIGHT CONE EXPANSIONS AND APPLICATIONS. Frishman, Y. (Weizmann Inst. of Science, Rehovot, Israel). pp 61-76 of Broken Scale Invariance and the Light Cone. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

An expansion of operator products at almost light like distances is suggested, which is a generalization of Wilson's expansion at short distances. A comparison is made with the short distance expansion. The case of deep inelastic electron–nucleon scattering is considered as an illustration and the relation to the Regge limit is also studied. An application of the expansion to exclusive processes is made. (L.B.S.)

21431 DEEP INELASTIC ELECTRON–HADRON SCATTERING AND REGGEISM. Fritzsch, Harald (Max-Planck-Institut fuer Physik und Astrophysik, Munich. Stanford Linear Accelerator Center, Calif.). pp 129-35 of Broken Scale Invariance and the Light Cone. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

A connection is established between Regge behavior and scaling behavior in deep inelastic electron–hadron scattering. (L.B.S.)

21432 MODEL FOR THE STRUCTURE FUNCTIONS OF INELASTIC ELECTRON–NUCLEON SCATTERING. Wataghin, Vladimir (Univ., Turin). pp 67-74 of Invited Papers. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

A model is proposed for the inelastic structure functions W_1 and W_2 based on two main assumptions: a previously developed model for the electromagnetic nucleon form factors; and the assumption that elastic and inelastic electron–nucleon scattering have the same dynamical origin. The model is shown to be in qualitative agreement with the observed behavior of structure functions. (L.B.S.)

21433 REPLY TO JANOSSY'S TREATMENT OF THE AHARANOV–BOHM EFFECT AND THE MANY-BODY PROBLEM. Bohm, D.; Phillipidis, C. (London Univ.). Acta Phys. Acad. Sci. Hung.; 30: No. 2, 221-6(1971).

It is pointed out that the hydrodynamical model does not resolve radically either the Aharanov–Bohm effect or the many-body problem. It reformulates them in terms of a different mathematical language, which may make the problem appear less urgent. (J.F.P.)

21434 MAGNETIC DIPOLE MOMENT OF THE ELECTRON IN THE LADDER APPROXIMATION. Zavada, John M. Jr. New York; New York Univ. (1971). 126p. University Microfilms Order No. 72-3150.

Thesis.

In order to calculate the magnetic dipole moment of the electron in a non-perturbative manner, the vertex function of quantum electrodynamics is considered in the ladder approximation. The vertex function is written as the sum of form factors and coupled, linear integral equations are derived for the form factors. After converting the system of integral equations into differential equations, the series solution of the form factors near their singular points is investigated. By using the leading term of the series solution, an approximation for the value of the magnetic dipole moment of the electron is obtained. This approximation is considered in the limit of a large coupling constant, $g^2/4 \sim 137$, and the electric dipole moment, μ_E, of a magnetic monopole is found to be: $\mu_E \sim (g^{-\frac{1}{2}} + g^{\frac{1}{2}} \exp -g/2)\ g/2m$. Then, assuming that the neutron is the bound state of magnetic monopoles, the electric dipole moment of a neutron is estimated as being 10^{-18} e-cm. (Diss. Abstr. Int., B)

Weak

Refer also to abstract 21499.

21435 (OULNS-71-3) LEPTON–BARYON RESONANCES AND DUALITY IN WEAK PROCESSES. Nakawaki, Yuji; Saito, Takesi; Sakai, Yosiki; Tanikawa, Yasutaka (Osaka Univ. (Japan). Lab. of Nuclear Studies). Mar 1971. 5p. NTIS (U. S. Sales Only).

The theory of duality for weak interactions is discussed. The μ^+n resonance lying on a Regge trajectory α_T, (u) as well as the

μ^-p resonance being considered to lie on a Regge trajectory α_T (s) was taken into consideration. A new model reduced the energy dependence of quantities corresponding to vector and axial vector form factors. The scattering amplitude for the process $\nu n \rightarrow \mu^- p$ was calculated. It was previously shown that interaction of the T boson is superweak. The interaction of T′ boson, therefore, was assumed to be also superweak. Invariant amplitudes F's in the scattering amplitude were shown with Veneziano model. Only the ρ trajectory $\alpha\rho$ (t) was considered as the Regge trajectory. Satellite terms were necessary in a formula for F_V. A special form was chosen for the satellite terms. Curves of F_V regarding t is given. Amplitude F_A is also shown. (KATO, T.)

21436 KAON MASS-SHELL FORM FACTORS IN K_{13} AND K_{14} DECAY. Wienke, B. R. (Northwestern Univ., Evanston, Ill.). Nuovo Cim.; 8A: No. 1, 1-14(1 Mar 1972).

Using factorization, meson dominance, PCAC and PCVC in the $(3^*, 3) \oplus (3, 3^*)$ model the form factors f_+ and f_- in K_{13} decay, and f_1 and f_2 in K_{14} decay are obtained in the soft-pion limit with the kaon on mass shell. This procedure leads to considerable simplification in the computation for the current algebra approach and yields good agreement with experiment. Contact with the analyses of others is also given. (auth)

21437 NEUTRINO-INDUCED PRODUCTION OF HADRONS AND THE WEINBERG SUM RULES. Hellman, W. S.; Singh, R. B. (Boston Univ.). Nuovo Cim.; 8A: No. 1, 79-84(1 Mar 1972).

Hadron production from leptons through the process $e^- + \bar{\nu} \rightarrow$ hadrons is considered. While experimentally not feasible at the present time the theoretical analysis of this reaction exhibits a test of the Weinberg sum rules for chiral $SU_3 \times SU_3$ current algebra which is relatively free of strong-interaction assumptions other than the sum rules themselves. This result is exact in the current–current form of the weak interaction. (auth)

21438 EXPERIMENTAL STUDY ON THE $\tau^\pm$ DECAY MATRIX ELEMENT. Ford, W. T.; Piroue, P. A.; Remmel, R. S.; Smith, A. J. S.; Souder, P. A. (Princeton Univ., N. J.). Contracts AT(30-1)-2137; AT(30-1)-4159. Phys. Lett.; 38B: No. 5, 335-8 (6 Mar 1972).

In a wire spark-chamber experiment the squared matrix element $|M|^2$ was measured for the processes $\tau^\pm (K^\pm \rightarrow \pi^\pm\pi^\pm\pi^\mp)$. Previous results showed no significant difference between τ^+ and τ^-. The final results, based on ~1.5 million $\tau^\pm$ decays, are expressed in the form $|M|^2 \propto 1 + aY + bX^2 + cY^2 + \ldots$, where X and Y are the Dalitz variables. The data are adequately fitted by a quadratic expansion where $a = 0.2752 \pm 0.0033$; $b = -0.038 \pm 0.009$; $c = 0.025 \pm 0.010$. Results are also given for τ^+ and τ^- separately. Finally the difference between the Q values of τ^+ and τ^- were determined to be: $Q^+ - Q^- = -60 \pm 55$ kev. (auth)

21439 DESCRIPTION OF LEPTON–HADRON REACTIONS IN QUANTUM FIELD THEORY. Polyakov, A. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2193-2208(Dec 1971). (In Russian).

Deep inelastic lepton–hadron reactions are studied within the framework of renormalized quantum field theory. Theories with zero charges are considered. Calculations of the reaction amplitudes are carried out completely in the major logarithmic approximation. It is also shown that the problem of determination of the amplitudes reduces to a determination of the dependence of the vertex parts of a certain set of operators on the cut-off radius. Renorm-group equations are derived for such vertex parts and the possible form of the equation solutions is discussed. (auth)

21440 VALIDITY OF THE WEAK INTERACTION RENORMALIZABLE THEORY OF TANIKAWA–WATANABE. Lobov, G. A.; Shabalin, E. P. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys.; B38: No. 1, 327-32(1972).

It is shown that the weak interaction renormalizable theory of Tanikawa–Watanabe, which in its simple formulation predicts essential effects in (e^+p) scattering, contradicts the experimental data on elastic scattering of electrons and positrons on protons if the existing concepts on the role of the two-photon exchange in these processes are valid. (auth)

21441 EXPERIMENTAL REVIEW OF WEAK INTERACTIONS. Pondrom, Lee G. (Univ. of Wisconsin, Madison). pp 151-80 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

The experimental data concerning the decays of K mesons is reviewed. (auth)

21442 WEAK INTERACTIONS: PROBLEMS AND PROSPECTS. Wolfenstein, L. (Carnegie-Mellon Univ., Pittsburgh). pp 204-13 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

Some of the experiments on weak interactions that should be performed in the next few years are discussed; these include checks of the standard theory; problems raised by $K_L \rightarrow \mu^+\mu^-$, CP and T violation; and probes of weak interactions at small distances. (L.B.S.)

21443 WEAK INTERACTIONS WITH COLLIDING LEPTON BEAMS OF ENERGY (10^2 TO 10^3) GeV. Dolgov, A. D.; Okun, L. B.; Zakharov, V. I. (Inst. for Theoretical and Experimental Physics, Moscow). pp 214-25 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

Weak V-A interaction of colliding lepton beams at high energies is considered. It is assumed that the weak coupling constant G is the only parameter inherent to weak leptonic interactions so that terms of higher order become appreciable at total energy $2E = s^{1/4}$ of order $G^{-1/4}$. It is shown that for colliding lepton antilepton beams of 2×250 GeV the contribution of weak interactions to the differential cross section of elastic scattering at angle $\Theta \simeq 90°$ prevails over that of electromagnetic interactions. The estimate of the weak cross section is based on the calculation of the imaginary part of the amplitude which is uniquely determined in the second order in G. Phenomenological description of the real part of the amplitude in the same approximation introduces a single unknown parameter. Provided the validity of dispersion relations with two subtractions is granted this parameter is related to the integral of total cross sections of ll and $l\bar{l}$ weak interactions. Terms of the third order in G are studied in a similar way and estimation of the magnitude of these terms is given. (auth)

21444 LEPTON CONSERVATION LAWS. Rosen, S. P. (Purdue Univ., Lafayette, Ind.). pp 226-35 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

The meaning of the lepton conservation law is examined from the point of view that if the lepton number is to be conserved, ν and $\bar{\nu}$ must differ from one another in at least one of their intrinsic properties. Various processes in which the neutrino and antineutrino take part are examined. Further tests which may be carried out in the next few years are also discussed. (L.B.S.)

21445 WEAK INTERACTION HAMILTONIAN IN L-MATRIX THEORY. Ramakrishnan, Alladi (Inst. of Mathematical Sciences, Madras). J. Math. Anal. Appl.; 37: No. 2, 432-4(Feb 1972).

It is pointed out that the form of the weak interaction Hamiltonian elementary particle physics is an interesting manifestation of shell structure in the anticommuting matrices with a consequent telescoping of eigenvalues of an L-matrix which is a linear combination of the anticommuting matrices. (J.F.P.)

Strong (General)

Refer also to abstracts 21029, 21508, and 21545.

21446 (NYO-3399-255) PREDICTIONS FOR ANNIHILATION PROCESSES. Amann, R. F. (Syracuse Univ., N. Y. Dept. of Physics). Sep 1971. 10p. (SU-4205-255). Dep. NTIS.

Strong duality is used to derive simple relations between the charge, baryon number and hypercharge annihilation processes and the differences of total cross sections. These relations fail if there is significant production of resonances that decay into $\pi^+\pi^-$, $N\bar{N}$ or $K\bar{K}$ pairs respectively. Thus they represent a direct test of the importance of such resonance production and, thus, of basic ideas of multiparticle production; in particular, they allow a possible discrimination between the multiperipheral and diffraction pictures. (auth)

21447 HADRONIC REACTIONS AND THE REARRANGEMENT OF SAKATONS. Imachi, Masahiro (Kyushu Univ., Fukuoka); Matsuoka, Takeo; Ninomiya, Kansuke; Sawada, Shoji. Progr. Theor. Phys. (Kyoto). Suppl.; No. 48, 101-45(1971).

From the viewpoint of the composite theory of hadrons, various kinds of hadronic reactions are discussed in terms of a model of the sakaton rearrangements (SR). It is shown that the SR diagrams

are closely related with the phenomenological characteristics of hadronic reactions such as the existence or absence of resonant states in the s-, t- and u-channels, etc., real to imaginary ratios of scattering amplitudes, dip structure of differential cross sections in the small momentum transfer region, the energy dependence of the cross sections for the two-body and the multiple-production processes at high energies and so on. (auth)

21448 CONTRADICTIONS BETWEEN THE DUALITY AND BOOTSTRAP PREDICTIONS FOR INTERNAL SYMMETRIES. Collins, P. D. B.; Hutt, P. K. (Univ. of Durham, Eng.). Nuovo Cim.; 8A: No. 1, 50-62(1 Mar 1972).

It is shown that, although both the duality hypothesis and N/D bootstraps lead to the same Lie-group structure for hadrons, the relationships they predict between the various multiplets are quite different. In particular, whereas duality requires degeneracies among the trajectories of different multiplets, these do not result from N/D models. Both meson and baryon trajectories are considered, and it is found that the most serious contradiction concerns the isosinglet mesons. In dual models the f and f′ trajectories are degenerate with the ω and φ, respectively. Orthogonal admixtures of them are identified with the SU_3 singlet, and the singlet member of the tensor octet. Bootstrap models, on the other hand, always produce a singlet which has a higher trajectory than the tensor and vector octets, and which is more naturally identified with the pomeron. It is argued that these contradictions make it unlikely that dual models can be deduced in any simple way from the bootstrap hypothesis, and that attempts to unitarize dual models with internal symmetries are likely to run into difficulties. (auth)

21449 CONFIGURATION MIXING IN THE QUARK PARTON MODEL. Etim, E. (Univ., Naples). Nuovo Cim.; 8A: No. 1, 97-107(1 Mar 1972).

A detailed analysis of the structure of the quark version of the parton model incorporating algebraic (SU_2 or SU_3) configurations and their mixing is given in which the only assumptions retained are those of the quark-parton identity. The model is shown to be wholly consistent but less predictive than applications of it would suggest. (auth)

21450 BACKGROUND IN MISSING MASS EXPERIMENTS. Bishari, M.; Yesian, H. J. (Univ. of California, Berkeley). Phys. Lett.; 38B: No. 5, 312-16(6 Mar 1972).

A mechanism is proposed whereby one can determine the background in missing mass experiments in the resonance region by extending two component duality to absorptive amplitudes with external reggeons. It is shown to explain naturally the very different trend of the background in the reactions $p + p \rightarrow p + X$ and $\pi^- + p \rightarrow p + X$ at available energies. The implications and limitations of this mechanism for the analysis of the spectrum are discussed. (auth)

21451 RISING REGGE TRAJECTORIES AND THE DUAL ABSORPTIVE MODEL. Fleming, H. (Univ., Sao Paulo, Brazil). Lett. Nuovo Cim.; 3: No. 8, 323-5(19 Feb 1972).

It is shown that the method of constructing the Harari-type amplitude by summing up an infinite recurrence of s-channel resonances is inconsistent with asymptotic behavior of Regge trajectories and widths that follows from analyticity. (L.B.S.)

21452 STATISTICAL-THEORY VIEW ON THE DUAL-RESONANCE MODEL. Gorenstein, M. I.; Makarov, V. I.; Miranskii, V. A.; Shelest, V. P.; Zinov'ev, G. M. (Inst. of Theoretical Physics, Kiev). Lett. Nuovo Cim.; 3: No. 9, 347-50(26 Feb 1972).

The statistical approach to level counting in the dual resonance model within the framework of the oscillator formalism is considered. The resonance spin distribution is calculated, and it is shown that in the dual resonance model with an infinite sequence of linear trajectories, a large amount of resonances lie close to the average value $\bar{I} \sim \sqrt{s}$. (L.B.S.)

21453 MODEL FOR THE POMERON. Barmawi, M.; Venturi, G. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 3: No. 9, 373-8(26 Feb 1972).

Some properties that the pomeron would be expected to have are briefly illustrated. A model is suggested that depends on the contribution of the third double-spectral function. It is shown from quark-duality diagrams that a spin structure for vertices involving P, f, and f′ trajectories is obtained which is compatible with experiment. (L.B.S.)

21454 GOLDBERGER-TREIMAN RELATION IN THE RENORMALIZED SIGMA MODEL. Strubbe, H. J. (Univ., Utrecht). Nucl. Phys.; B38: No. 1, 299-315(1972).

The regularization and renormalization of the full sigma model is worked out explicitly in the tree and one-loop approximation. Various renormalized quantities relevant for chiral symmetry breaking are listed. The numerically calculated Goldberger–Treiman relation is also compared with experiment. (auth)

21455 SOME REMARKS CONCERNING THE PARTON MODEL. Leutwyler, H. (Institut fuer Theoretische Physik, Bern). pp 113-21 of Broken Scale Invariance and the Light Cone. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

A formulation of the parton model is presented in terms of an infinite momentum picture of the nucleon. The charged partons are described by the spinor $\varphi(x)$, and the basic assumption is that the leading singularity of this field on the light cone is a canonical one. The model is used for obtaining electromagnetic form factors of the nucleon. (L.B.S.)

21456 MULTIPERIPHERAL DYNAMICS. Lectures from the Conference on Fundamental Interactions at High Energy, Coral Gables, Florida, January 20–22, 1971. Dal Cin, Mario; Iverson, Geoffrey J.; Perlmutter, Arnold (eds.). Tracts in Mathematics and Natural Sciences. Volume 5. New York; Gordon and Breach, Science Publishers, Inc. (1971). 88p. (CONF-710106-(Vol.5)).

Separate abstracts are prepared for the four lectures included. (L.B.S.)

For abstracts of individual lectures see: 21457–21460.

21457 DIFFRACTIVE DISSOCIATION AND MULTIPERIPHERALISM. INTRODUCTION. Chew, Geoffrey F. (Princeton Univ., N. J.). pp 1-18 of Multiperipheral Dynamics. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

A unified picture of multiperipheralism and diffraction dissociation based on the ABFST model is presented. (L.B.S.)

21458 REGGE MODEL IN MULTIPARTICLE PHENOMENOLOGY. Chan, Hong-mo (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. pp 19-47 of Multiperipheral Dynamics. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

A brief review is given of the phenomenology of multiparticle reactions with the Regge model at energies below 20 GeV. Exclusive and inclusive interactions are discussed in regard to the double and dual role of the Regge trajectory. (L.B.S.)

21459 RESULTS ON INCLUSIVE REACTIONS FROM REGGE ASYMPTOTIC BEHAVIOR. Mueller, Alfred H. (Brookhaven National Lab., Upton, N. Y.). pp 48-61 of Multiperipheral Dynamics. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

An analysis of results on single particle inclusive reactions is presented. Kinematics, rapidity variables, O(2,1) expansions, and multiplicity distributions are discussed. (L.B.S.)

21460 REGGE PHENOMENOLOGY OF SINGLE PARTICLE PRODUCTION. DeTar, Carleton (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. pp 62-77 of Multiperipheral Dynamics. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

General Regge phenomenology for single particle production is discussed under the following topics: tests of limiting fragmentation; search for invariant central region; and diffractive dissociation and the triple Pomeranchuk vertex. The dual resonance model is then discussed, which gives a detailed prediction for the momentum distribution. (L.B.S.)

21461 RECENT EXPERIMENTAL RESULTS ON MULTIPARTICLE PRODUCTION. Lander, Richard L. (Univ. of California, Davis). pp 71-98 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

Selected (almost exclusively bubble chamber) experiments relating to scaling, limiting fragmentation, and factorization are briefly reviewed. Special attention is paid to exotic versus non-

exotic (in the $ab\bar{c}$ sense) reactions. Also discussed are experiments suggesting non-limiting behavior for $K\bar{K}$ production below 30 GeV and for cosmic ray interactions above 10 TeV. Observation of isotropic $\pi^{\pm}$ and K^0 production with Bose–Einstein energy distributions and a common "temperature" equal to the pion mass is reported. (auth)

21462 NATURE OF HIGH ENERGY INTERACTIONS. Low, F. E. (Massachusetts Inst. of Tech., Cambridge). pp 124-30 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

The characteristics of diffraction scattering in the J-plane formalism and strong interactions are discussed. Comments are given on electromagnetic effects in a region where they may dominate. (L.B.S.)

Strong (Baryon No. = 0)

21463 PERTURBATION SERIES FOR CHIRAL LAGRANGIANS. I. Chan, W. K.; Curiale, J. S. (Yale Univ., New Haven). Contract AT(30-1)-2726. Nuovo Cim.; 8A: No. 1, 29-38(1 Mar 1972).

Using the techniques of nonpolynomial Lagrangian field theory, an approximation to the superpropagator for a chiral Lagrangian is calculated. In this approximation the superpropagator goes to zero like $s'^{-4} \exp[-s']$ as $s \to \infty$. Here $s' = s\lambda^2/16\pi^2$, where λ is the inverse pion decay amplitude and s is the invariant (energy)^2. (auth)

21464 PERTURBATION SERIES FOR CHIRAL LAGRANGIANS. II. Ng, W. C. (Princeton Univ., N. J. New York Univ., N. Y.); Chan, W. K. Contract AF-49(638)-1545. Nuovo Cim.; 8A: No. 1, 39-49(1 Mar 1972).

Using the Efimov–Fradkin perturbation series, a Ward identity was checked for a chiral-symmetric pion Lagrangian. There is no massless singularity in the time-ordered product to lowest order. It is argued that this is a reflection of the violation of chiral invariance of the perturbation scheme, and it explains the nonzero mass found for the pion with this Lagrangian in an earlier paper. (auth)

21465 DISCRETE ENERGY SPECTRUM ASSOCIATED WITH A TWO-FERMION SYSTEM AND THE MASSES OF VECTOR MESONS. Bogush, A. A.; Ostapenko, A. V. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 79-85(1971). (In Russian).

The work of Ronchka and coworkers, obtained for coupled two-fermion systems with J = 0, was generalized for the case of an arbitrary nonzero total moment of the system (J). The solution for the radial portion of the simultaneous Bethe-Salpeter equation was found; a more general condition which fixes the energy spectrum of the system for an interaction potential is taken in the form of a square-well. The possible values of free parameters were calculated for the equation which determines the experimental mass values of vector mesons, regarded as states of the coupled quark–antiquark system with J = 1 in broken unitary symmetry. (tr-auth)

21466 PARTICLE CREATION IN ISOTROPIC COSMOLOGIES. Parker, Leonard (Univ. of Wisconsin, Milwaukee. Princeton Univ., N. J.). Phys. Rev. Lett.; 28: No. 11, 705-8(13 Mar 1972).

The simplest covariant generalization of the scalar wave equation leads to significant pion creation and annihilation processes near an isotropic Friedmann-type singularity (such processes are negligible for particles of nonzero spin). Estimates for a plausible initial state yield pion creation of the same order of magnitude as obtained by Zeldovich near an anisotropic Kasner-type singularity. (auth)

21467 HARD MESON CALCULATION OF $\sigma\pi\pi$, $A\sigma\pi$ AND σAA VERTICES. Kleinert, H.; Staunton, L. P.; Weisz, P. H. (CERN, Geneva). Nucl. Phys.; B38: No. 1, 104-24(1972).

The low-energy theorems on the $\theta A_\mu A_\nu$ vertex following from current algebra and from the dimensional properties of the various components of the axial vector current A_μ and of its divergence $\partial^\mu A_\mu$ are extended to finite momenta assuming σ-dominance of the trace of the energy momentum tensor θ and pion and A_1 dominance of A_μ. Smooth vertex functions are determined for the $\sigma\pi\pi$, $\sigma A\pi$ and σAA couplings. The role of Schwinger terms in the extrapolation from the low-energy points is discussed. (auth)

21468 ϵ-MESON COUPLING CONSTANTS AND SCALE INVARIANCE BREAKING. Petersen, J. L.; Pisut, J. (CERN, Geneva). Nucl. Phys.; B38: No. 1, 207-220(1972).

A general method for obtaining ratios of coupling constants (defined by pole residues) in a way which is completely free of resonance/background separation troubles is devised and applied to the ϵ-meson. Huge discrepancies between previous determinations are shown to arise (i) from inherent ambiguities in the methods used, (i) from inherent ambiguities in the methods used, (ii) from lack of knowledge about the ϵ-pole position and (iii) from the well-known up–down ambiguity in the isospin-0 s-wave $\pi\pi$ phase shift δ_0^0. Taking as input πN phase shifts, available information on δ_0^0 and including all possible uncertainties we find for down–up or up–up δ_0^0: $g_{\epsilon NN}/g_{\epsilon\pi\pi} = (6 \pm 3)\ \mu^{-1}$, and for down–down or up–down δ_0^0: $g_{\epsilon NN}/g_{\epsilon\pi\pi} = (1.8 \pm 0.5)\ \mu^{-1}$. The precise validity of the scale invariance breaking prediction $(g_{\epsilon NN}/g_{\epsilon\pi\pi})$. $m_\epsilon^2/2M = 1$ is fulfilled in some theoretical $\pi\pi$ models having $\Gamma_\epsilon \approx m_\epsilon \approx 500$ MeV and δ_0^0 of up–down type, but is excluded if δ_0^0 is down–up or up–up. (auth)

21469 MODIFIED SHIRKOV EQUATIONS IN PION SCATTERING. Atkinson, D. (Univ. of Texas, Austin). Nucl. Phys.; B38: No. 1, 316-26(1972).

A conformal mapping of the momentum-transfer plane is used to remove the divergence in the pion–pion equations in the differential approximation. The new equations, involving flexible expansion coefficients, are written down in a form suitable for a rigorous existence proof on the one hand, and for a numerical computation on the other. (auth)

21470 RESONANCES IN A NUCLEON–ANTINUCLEON SYSTEM. Bogdanova, L. N.; Dal'karov, O. D.; Mandel'tsveig, V. B.; Shapiro, I. S. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2242-7(Dec 1971). (In Russian).

Regge trajectories, masses, elastic and total resonance widths in the nonrelativistic $N\bar{N}$ system are calculated. The results obtained indicate two characteristic features of heavy mesons of a quasinuclear nature. These are large (of the order of 10 to 30 MeV) partial widths for the $N\bar{N}$ decay channel and restriction of the resonance spectrum from above by masses of the order of 2.0 to 2.3 GeV due to strong growth of the annihilation probability at small distances. (auth)

21471 SUM RULE FOR THE VERTICES $K^* \to K\pi$ AND $K_A \to K\pi$. Ferenczi, G. (Lorand Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 2, 125-9(1971).

The method, based on the techniques of current algebra and dispersion relations, is used for calculating the ratio of the d and s wave coupling of the vertex $\langle K_A|J_\pi|K^*\rangle$. A limitation for the pole approximation is obtained, and applying the general results of Lai the $\Gamma(K^* \to K\pi)$ and $\Gamma(K_A \to K^*\pi)$ decay widths are calculated in good agreement with recent experimental data. In the calculation the Weinberg broken sum rules are applied. (auth)

21472 ASYMPTOTIC BEHAVIOR OF REGGE TRAJECTORIES AND WIDTHS. Fleming, H. (Univ., Sao Paulo, Brazil). Lett. Nuovo Cim.; 3: No. 9, 363-5(26 Feb 1972).

A method based on the Phragmen–Lindeloff theorem for construction of meson Regge trajectories has shown that the width of the resonances increases asymptotically as the $\sqrt{s}$, provided the trajectory has a finite (small asymptotic phase). It is shown that the introduction of logarithmic factors in this method turns out to be important for parabolic asymptotic behavior of Re $\alpha(s)$. (L.B.S.)

21473 SOME TOPICS IN BOSON SPECTROSCOPY. Trilling, George H. (Univ. of California, Berkeley). pp 1-39 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

Some aspects of various natural-spin parity $[P = (-1)^J]$ nonets are discussed, which include the 2^+ nonet, low-energy $K\pi$ and $\pi\pi$ spectroscopy, and higher energy and angular momentum $K\pi$ and $\pi\pi$ scattering. Brief comments are then given on some of the diffractively-produced unnatural-spin parity system. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstract 21376.

21474 POMERON COUPLING TO THE $A\pi$ SYSTEM. Merlani, A.; Violini, G. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Lett. Nuovo Cim.; 3: No. 4, 166-8(22 Jan 1972).

According to the Harari interpretation of the finite-energy sum rules duality between Regge poles and resonances, the pomeron is dual to the background and the remaining Regge poles to the

s-channel resonances. The Harari proposal is tested in the case of forward $\Lambda\pi$ scattering, using the $\Lambda\pi$ scattering amplitude obtained from a previous analysis of $\bar{K}N$ scattering. Support is found for the validity of the Harari model. (L.B.S.)

21475 TWO-PION EXCHANGE CONTRIBUTION TO $\pi^-p \to \pi^0 n$. Moore, R. W. (Westfield Coll., London); Moriarty, K. J. M. Lett. Nuovo Cim.; 3: No. 4, 151-5(22 Jan 1972).

A model is presented for calculating the 2π-exchange contribution to the interaction $\pi^-p \to \pi^0 n$ at 9.8, 13.3, and 18.2 GeV/c. The differential cross sections, with absorptive corrections, are found to be close to the experimental results. (L.B.S.)

21476 RECOIL EFFECTS IN A MODEL OF HIGHER BARYON COUPLINGS. I. PHOTOPRODUCTION. Mehrotra, Rashmi; Mitra, A. N. (Univ. of Delhi). Phys. Rev., D; 4: No. 5, 1409-22(1 Sep 1971).

A recently proposed model (MM) of higher baryon couplings for P and V mesons is reformulated by reviewing the fuller possibilities of the "recoil term" in the primitive quark-meson interaction. While this introduces no basic change in the P-meson coupling structures, it yields an entirely new $(L-1)$-wave coupling of V mesons to $J = L + \frac{1}{2}$ baryons, which is capable of generating helicity-flip amplitudes. The advantage of this new coupling structure over the earlier one is demonstrated through the excellent reproduction of (i) the E1 angular distribution in $Y^* \to \Lambda\gamma$ decay and (ii) the appreciable magnitudes as well as energy variations of the asymmetry parameter $\Sigma(\theta)$ in pion photoproduction. In addition to a comparison of the two coupling structures (old and new), the role of still another parametric structure for the form factor is studied — one which exhibits better convergence properties at higher energies than those discussed in MM. The additional processes studied in this connection are (i) η and X_0 photoproduction at intermediate energies (>2 GeV), (ii) polarization of the recoil proton in η and π photoproduction, and (iii) π^0 photoproduction at high energies (~6 GeV), in accordance with our earlier scheme of s-channel resonances. In connection with η photoproduction the roles of some pertinent $I = \frac{1}{2}$ resonances such as S_{11}, P_{11}, and G_{17} are discussed, especially in relation to supermultiplet assignments. (auth)

21477 PERIPHERALITY AND πN SCATTERING. Ross, M. (Westfield Coll., London. Univ. of Michigan, Ann Arbor). Phys. Lett.; 38B: No. 5, 321-4 (6 Mar 1972).

πN amplitudes, as far as they have been deduced, are used with an absorbed Reggeon exchange model to obtain amplitudes at larger $-t$ with specified phases. Thus, satisfactory peripheral amplitudes are found. The phase behavior of the diffraction amplitude is discussed. (auth)

21478 NON-FLIP CUTS. Johnson, R. C. (Durham Univ., Eng.). Phys. Lett.; 38B: No. 5, 325-9(6 Mar 1972).

The effective elastic scattering necessary to generate cut corrections to non-flip ρ exchange in πN scattering through the absorption prescription is deduced. Its structure is a consequence of the cut being largely imaginary and approximately vanishing at $t = 0$. Absorbing other non-flip exchanges with the same "elastic scattering" leads to the even-signature exchanges (f^0-like and A_2-like) apparently choosing no-compensation, and to the correct systematics of differential cross sections and polarizations for the hypercharge-exchange (K^*-K^{**}) reactions connected by line-reversal. (auth)

21479 SEMI-THEORETICAL FORMULA FOR THE MAIN SERIES IN THE BARYON-MASS SPECTRA. Rosen, G. (Drexel Univ., Philadelphia). Lett. Nuovo Cim.; 3: No. 8, 320-2(19 Feb 1972).

A simple extension of a semi-theoretical formula for the masses of the isospin multiplet members of $L = 0$ baryon octet and decuplet is given, which accounts for the masses of the isospin multiplet masses of the main series in the baryon spectra, namely the unitary multiplet characterized by even L and a maximal eigenvalue for $L-S$. The mass values for isospin multiplet members of octets and decuplets in the main series are tabulated. (L.B.S.)

21480 SEMI-THEORETICAL FORMULA FOR THE SUPPLEMENTARY SERIES IN THE BARYON MASS SPECTRA. Rosen, G. (Drexel Univ., Philadelphia). Lett. Nuovo Cim.; 3: No. 8, 339-43(19 Feb 1972).

A previously reported formula for the central and isospin masses in the main series of baryon octets and decuplets (characterized by $J^P = (L+S)^+$) is extended and shown to apply also for the two supplementary series of baryon octets and decuplets (characterized by $J^P = (L+S)^-$ and $J \neq (L+S)$). The mass values are tabulated. A simple modification of the semi-theoretical formula yields the mass values observed for the unitary singlet Λ's. (L.B.S.)

21481 NO-EXOTICS-NOGO THEOREMS AND INCLUSIVE REACTIONS. Kugler, M. (Weizmann Inst. of Science, Rehovoth, Israel); Rittenberg, V.; Lipkin, Harry J. pp 106-9 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

The process $a + E \to a + E$, where E is an exotic baryon, is relevant to the inclusive reaction $a + b \to c + X$, with E representing the $(\bar{c}b)$ system. The theorem proves that an amplitude which vanishes when (aE) is exotic and which also vanishes for exotic exchanges in the $(\bar{a}a)$ channel must vanish for any octet meson a, even when (aE) is not exotic. Thus in a kinematic region where the inclusive reaction is described by coupling the conventional Regge trajectories to the $(\bar{a}a)$ channel and exotic exchanges are forbidden, an amplitude which vanishes when $(ab\bar{c})$ is exotic will also vanish when $(b\bar{c})$ is exotic and $(ab\bar{c})$ is not exotic; i.e. whenever the fragmentation vertex $b \to c$ involves an exotic exchange. The assumption that certain "exotic" amplitudes vanish in inclusive reactions has been shown to lead under certain reasonable assumptions to the conclusions that certain other amplitudes must also vanish, even though they are not normally considered exotic. The exact implications and the validity of this result have been questioned. A theorem is presented which provides a concise and systematic statement of which non-exotic amplitudes must also vanish when the criterion of Chan et al is assumed. The dynamical discussion of which criterion of exoticity is the proper one to use for inclusive reactions is not considered. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 21374, 21490, 21630, and 21850.

21482 CROSS-OVER, EXCHANGE DEGENERACY, AND ISR pp SLOPE PARAMETER. Uematsu, T. (Kyoto Univ.). Lett. Nuovo Cim.; 3: No. 4, 137-40(22 Jan 1972).

CERN ISR experiments on small-angle elastic pp scattering have shown that the shrinkage rate of the forward peak at these high energies is lower than that of the Serpukhov region. It is shown that the incorporation of the exchange-degenerate scheme for Regge residues at $t = 0$ can account for the decrease of the shrinkage rate at high energies by introducing a suitable amplitude parametrization. It is also shown that, in this case, the cross-over zero in the amplitude plays an important role. (L.B.S.)

21483 PROBLEMY FIZIKI ELEMENTARNYKH CHASTITS I ATOMNOGO YADRA. ECHAYA. TOM 2, VYPUSK 1. (Problems of Elementary Particle and Atomic Nucleus Physics. Particles and Nucleus. Volume 2, Part 1). Bogolyubov, N. N. (ed.). Moscow; Atomizdat (1971). 280p.

The general approach to the investigation of deep inelastic lepton–hadron interactions, based on the automodelity, current algebra and vector dominance is used. The automodel character of the form factors of electromagnetic or weak processes makes it possible in the asymptotic domain to decrease by unity the number of independent variables and by combining with current algebra to deduce sum rules of a special type, which allow one to answer, in principle, the fundamental question about the structure of electromagnetic or weak hadronic currents. It is shown that the problem of the automodelity violation is connected with the idea of the breakdown of the conformal symmetry up to the Poincare group. The process of dimuon production in deep inelastic proton–proton collision $p + p \to \mu^+ + \mu^-$ + hadrons is considered in detail. (auth)

21484 MESON EXCHANGE EFFECTS IN $n + p \to d + \gamma$. Riska, D. P. (State Univ. of New York, Stony Brook); Brown, G. E. Contract AT(30-11)-4032. Phys. Lett.; 38B: No. 4, 193-5(21 Feb 1972).

It is shown that an exchange-current correction of ~10% of the threshold neutron capture $n + p \to d + \gamma$ can arise in a straightforward way from one-pion-exchange terms, most of it coming from the exchange moments written down by Villars in 1947. A large part of the correction comes from $^1S_0$ to $^3D_1$ terms, which have generally been overlooked. (auth)

21485 MULTIPLE-SCATTERING EFFECTS IN QUASI-FREE SCATTERING. Abul-Magd, A. Y.; Guardiola, R. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim.; 8A: No. 1, 108-18(1 Mar 1972).

The Glauber multiple-scattering theory is applied to the study of quasi-free scattering of high-energy protons by nuclei. The multiple scattering of the knocked-out nucleon is not considered.

The differential cross section is written as a sum of different terms corresponding to single, double, ..., incoherent scattering of the incident nucleon inside the target nucleus. It is shown that the single-scattering term is similar to the outcome of the distorted-wave impulse approximation. The theory is compared with the experimental cross-section of the quasi-free scattering of 1 GeV protons from ^{12}C and the agreement is satisfactory at forward angles. The contribution from double-scattering terms appears to be rather important. (auth)

21486 DUALITY PREDICTIONS ON THE ISR DATA OF pp → pX NEAR THE PHASE-SPACE BOUNDARY. Dias de Deus, J. (Institut de Physique Nucleaire, Orsay, France); Lam, W. S. Phys. Lett.; 38B: No. 5, 317-20(6 Mar 1972).

Applying the Harari–Freund duality hypothesis to the inclusive reaction pp → pX near the phase space boundary, a prediction is given on the small transverse momentum squared, $(p\hat{c}_j)^2$, distribution of the ISR data. Also, using the Feynman scaling variable, x, the exponential $(p\hat{c}_j)^2$ dependence of the Lorentz invariant cross sections $E_c d^3\sigma/dp_c^3$ is explicitly demonstrated from the triple-Regge formula. (auth)

21487 ASYMPTOTIC HIGH-ENERGY BEHAVIOR OF PRODUCTION MULTIPLICITIES. Arnold, R. C. (Argonne National Lab., Ill.). Lett. Nuovo Cim.; 3: No. 8, 305-8(19 Feb 1972).

A simple model of cascading interactions in hadronic matter, in which each primitive interaction is described by a conventional pole theory, is examined. The successive interactions of secondaries, as the shower develops, can result in a final average multiplicity which grows faster than ln s as the primary incident energy increases indefinitely. The basic picture is adapted (in terms of scale of energy and co-ordinate system) to describe proton–proton scattering. (L.B.S.)

21488 MULTIBARYON RESONANCES IN THE ISOBAR–NUCLEON EXCHANGE INTERACTION MODEL. Karmanov, V. A.; Kondratyuk, L. A.; Shapiro, I. S. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2185-92(Dec 1971). (In Russian).

An analysis of the interaction in Δ2N, Δ3N and Δ4N systems is carried for a model in which interaction between a Δ-isobar and nucleon is due to "decay" π-meson exchange. It is shown that the isobar and nucleons can combine into a multibaryon resonance only in a Δ3N system in a state with quantum numbers $T = 1$ and $J^P = 1^+$. (auth)

21489 POSSIBLE RELATION BETWEEN STRUCTURE AT VERY SMALL MOMENTUM TRANSFERS AND DIFFERENT CONTRIBUTIONS TO TOTAL INELASTIC CROSS-SECTIONS AT VERY HIGH ENERGIES. Barshay, S. (Univ. of Copenhagen). Lett. Nuovo Cim.; 3: No. 9, 369-72(26 Feb 1972).

The cluster model incorporating two distinct mechanisms contributing to the n-particle cross section is used to illustrate the possible connection between the nature of the individual contributions to asymptotic total inelastic cross sections and structure at very small $|t|$ in quasi-two-body and elastic $d\sigma/dt$. (L.B.S.)

21490 COULOMB-NUCLEAR INTERFERENCE IN THE MULTIPLE COLLISION MODEL. Lesniak, H.; Lesniak, L. (CERN, Geneva). Nucl. Phys.; B38: No. 1, 221-46(1972).

Coulomb and strong interactions in the elastic scattering of hadrons from light nuclei are studied in the framework of the Glauber multiple scattering model. The accuracy of the Bethe formula for the small-angle scattering is examined. Other related approximations are also investigated and the results are compared with the experimental data. (auth)

21491 TWO-PION-EXCHANGE NUCLEON–NUCLEON POTENTIAL. Chemtob, Marc (Univ. of Copenhagen); Durso, J. W.; Riska, D. O. Nucl. Phys.; B38: No. 1, 141-206(1972).

A two-pion-exchange nuclear potential is calculated using the dispersion theory construction. The field-theoretic nucleon–nucleon amplitude has the full two-pion contribution. The description allows for the inclusion of information on the elementary processes, $\pi N \to \pi N$ and $N\bar{N} \to \pi\pi$. The potential is constructed by removing from the field-theoretic amplitude the iteration of the one-pion-exchange potential, for which the three-dimensional Blankenbecler–Sugar–Logunov–Tavkhelidze equation, rather than the Lippmann–Schwinger equation, is used. It is shown that the TPEP so calculated meets the requirements of being real and weakly dependent on energy. Spectral representations are derived which allow one to express the configuration space potentials as a continuous superposition of Yukawa potentials. Several models are considered corresponding to various descriptions of the elementary processes. The results, with ω- and η-exchange contributions added, are compared with phenomenological nuclear potentials. Fairly good agreement is obtained, progressively improving as further information on the elementary processes is included. (auth)

Particle Invariance Principles and Symmetries

Refer also to abstracts 21929 and 21931.

General

Refer also to abstract 21512.

21492 VECTOR AND TENSOR REPRESENTATIONS OF THE POINCARE GROUP. Bracci, L. (Scuola Normal Superiore, Pisa, Italy. Univ., Pisa, Italy). Nuovo Cim.; 8A: No. 1, 129-46(1 Mar 1972).

The representations of the Poincaré group on the space of vectors $A_\mu(K)$ and symmetric tensors $h_{\mu\nu}(K)$ are analyzed. It is proved that for vanishing mass one cannot have a unitary vector (tensor) representation with helicity ±1 (±2). To reconcile covariance and unitarity the concept of induced representations is introduced. It is shown that one can get induced unitary representations of helicity ± 1 and ± 2 from the vector and tensor representations, which are essentially those used in Gupta's quantization of Maxwell and Einstein equations. Thus Gupta method is seen to be intimately connected with the requirement of unitarity of the representation of the Poincaré group. Therefore its introduction can be made independent of any condition of the Hilbert–Lorentz type, since in a group-theoretical framework it follows in a natural way. (auth)

21493 INTERACTIONS IN AN EXPLICIT MODEL OF ISOSPACE. Hillion, P. (Institut Henri Poincare, Paris). Nuovo Cim.; 8A: No. 1, 15-28(1 Mar 1972).

A preceding model of isospace is extended with introduction of space–time properties of fields, and hadron interactions are discussed in the frame of a Lagrangian formalism. The interaction Lagrangian is expanded in a series, each term of which, invariant under either the U_2 group of I-spin or the U_2 group of U-spin, describes a different type (strong, weak, electromagnetic ...) of interaction. The results are in good agreement with experimental facts. (auth)

21494 CANONICAL SCALING AND CONFORMAL INVARIANCE. Ferrara, S. (CNEN, Frascati, Italy); Grillo, A. F.; Paris, G.; Gatto, R. Phys. Lett.; 38B: No. 5, 333-4(6 Mar 1972).

Arguments are given to show that a strictly conformal invariant skeleton theory is compatible with observed scaling only if it possesses an infinite number of local tensors of spin $n = 2, 4, \ldots$ and scale dimension $l_n = 2 + n$, which are all conserved. The conclusion suggests that conformal invariance is spontaneously broken. (auth)

21495 SU(4) VAN DER WAERDEN INVARIANT. Sharp, R. T.; Lee, David (McGill Univ., Montreal). Rev. Mex. Fis.; 20: No. 3, 203-15(1971).

A solution for the SU(4) external labeling problem, symmetric within a phase factor, is found by explicit construction of the general van der Waerden invariant as a product of elementary scalars. The connection between external and internal multiplicity is demonstrated by exhibiting a one-to-one correspondence between product IR's and internal states. The groups SU(2) and SU(3) are similarly treated for illustrative purposes. (auth)

21496 BROKEN SCALE INVARIANCE AND THE LIGHT CONE. Lectures from the Conference on Fundamental Interactions at High Energy, Coral Gables, Florida, January 20–22, 1971. Dal Cin, Mario; Iverson, Geoffrey J.; Perlmutter, Arnold (eds.). Tracts in Mathematics and Natural Sciences. Volume 2. New York; Gordon and Breach, Science Publishers, Inc. (1971). 157p. (CONF-710106-(Vol.2)).

Separate abstracts were prepared for eight of the ten included lectures. The other two lectures were previously abstracted for NSA and appeared as CONF-710106-2 and -9. (L.B.S.)

For abstracts of individual lectures see: 21398, 21430, 21431, 21455, 21497, 21500, 21502, and 21527.

21497 DETERMINING THE DIMENSION OF THE CHIRAL INVARIANCE BREAKING TERM IN THE ENERGY MOMENTUM TENSOR. Segre, Gino (Massachusetts Inst. of Tech., Cambridge). pp 99-105 of Broken Scale Invariance and the Light

Cone. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

A sum rule is obtained for determining the dimension of the chiral invariance breaking term in the energy–momentum tensor. (L.B.S.)

Applications (Electromagnetic and Weak)

Refer also to abstract 21817.

21498 $\Delta T = 1/2$ SELECTION RULE IN THE CP-VIOLATING WEAK INTERACTIONS. Szymacha, A.; Tatur, S. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 19: No. 11, 1069-71(1971).

Assuming the slightly modified Glashow model for the CP violating weak interactions, and Ne'eman's proposal for strong Hamiltonian, it is shown that the effective Hamiltonian responsible for the CP violating, hadronic decays exhibits the $\Delta T = 1/2$ selection rule. (auth)

21499 VIOLATION OF CP-INVARIANCE IN THREE-PARTICLE DECAYS OF K MESONS. Shakhbazyan, V. A. (Erevan Physics Inst.). Nucl. Phys.; B38: No. 1, 286-98(1972).

The derivation and the solution of integral equations for 3π decay of K^0 are performed. Equations are obtained using a one-dimensional Mandelstam representation for the transition amplitude of two particles with one of the particle masses analytically continued up to the decaying values and in the case of two-body unitarity condition written taken into account a possible violation of CP invariance. The solutions of the equations obtained for the neutral case are analyzed taking into account the contribution of anomalous singularities. (auth)

21500 SCALING LAW AND SCALE INVARIANCE. Mack, G. (Univ., Munich). pp 106-12 of Broken Scale Invariance and the Light Cone. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

The scaling law of electroproduction is derived in the sense that the moments of the usual electroproduction structure functions W_1 and W_2 scale correctly. The dimension of a field is defined in terms of a hypothetical completely symmetric skeleton theory. (L.B.S.)

Applications (Strong)

21501 SYMMETRY OF STRONG INTERACTIONS. Nakamura, Seitaro (Max-Planck-Institut fuer Physik und Astrophysik, Munich); Sato, Shigeo. Progr. Theor. Phys. (Kyoto), Suppl.; No. 48, 1-40(1971).

The symmetry of strong interactions and weak interactions is formulated in terms of the four-dimensional charge space of $SU(2) \times SU(2)$ or O(4), where the isospin, τ, and the "hypercharge spin," ξ, are considered as two independent spin matrices. The wave functions of baryons and mesons in this charge space are assumed to be composed of the eigenfunctions t of τ_3 and s of ξ_3, and to transform according to the representations $(\frac{1}{2}, 0)$ and $(0, \frac{1}{2})$, respectively. As the basic wave functions which span an irreducible representation space allowing the reflection operations in the charge space, which give rise to the transformations $t \rightleftharpoons s$, one needs sixteen kinds of baryons and also sixteen kinds of mesons, if one assumes that the ground state particles are described in terms of the bilinear products t^*t, s^*s, t^*s and s^*t. The sixteen kinds of particles are made of a singlet, a triplet and a quartet which correspond to an octet in SU(3) symmetry and their countermultiplets which come out by exchanging $t \rightleftharpoons s$. Among the latter multiplets, a "hypercharge spin" triplet of baryons Z^+ $(Y = +2)$, $\Lambda^*(Y = 0)$, $\Omega^-(Y = -2)$ and of mesons $D^+(Y = +2)$, D^0 $(Y = 0)$, $D^-(Y = -2)$ are introduced as the countermultiplets of Σ hyperon and π meson, respectively. Also an attempt is made to classify baryon isobars and meson isobars in terms of the higher configurations of t, t^* and s, s^*. It is remarkable that a new selection rule of "hypercharge independence" is very powerful in explaining the suppression of some of the decay modes which are otherwise hard to understand. It may also be satisfactory to see that the allowed modes are described in terms of symmetric interactions, while the forbidden modes of decay are invoked in terms of the meso-strong symmetry breaking interactions on the basis of the present scheme of $SU(2) \times SU(2)$ symmetry. The possible experiments which could afford tests of the present scheme are cited within the framework of strong interactions only. The theorem by Okun and Pomeranchuk for high energy scattering in the asymptotic region is extended to include hypercharge independence in addition to charge independence, and good results are obtained in the case of kaon-nucleon scattering; also predictions are obtained which can be easily tested by the experiments in the case of antiproton (proton)-nucleon scattering in the asymptotic region. Discussions are made on the various results deduced from the present scheme of $SU(2) \times SU(2)$, in comparison with those obtained from the SU(3) scheme. (auth)

21502 APPROXIMATE SCALE AND CHIRAL INVARIANCE. Ellis, John (CERN, Geneva). pp 77-98 of Broken Scale Invariance and the Light Cone. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

The effective Lagrangian formalism for scale and chiral symmetries is reviewed. Applications of the Lagrangian models to mass formulas for σ and pseudoscalar mesons, the $\epsilon(700) \rightarrow 2\pi$ decay width, the matrix elements of the energy-momentum tensor between hadron states, and low-energy meson–nucleon scattering are described. Conclusions are drawn and future directions are suggested. (L.B.S.)

Field Theories

General

21503 LINEAR FIELD EQUATIONS FROM A NONLINEAR ELECTROMAGNETIC LAGRANGIAN. Boillat, G. (Univ., Messina, Italy). Phys. Lett.; 38A: No. 3, 181-2(31 Jan 1972).

If it is only assumed that the electromagnetic tensor is antisymmetric the field equations derived from a nonlinear Lagrangian can be reduced to linear differential equations by a change of field variables. In contradistinction the restriction to a rotational tensor leads to nonlinear electrodynamics. (auth)

21504 SPIN-2 FIELD THEORY IN CURVED SPACE. Yilmaz, Hueseylin (Perception Tech. Corp., Winchester, Mass.). pp 256-8 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

A theory of massless spin-2 field in curved space is described. A functional solution to the field equation is obtained. Gravitation is suggested as the most natural physical interpretation. (L.B.S.)

Quantum Field Theory

Refer also to abstracts 21428, 21454, 21492, 22165, and 22167.

21505 CLAUSIUS–DUHEM INEQUALITY FOR RELATIVISTIC CONTINUOUS MEDIA. Maugin, Gerard. Compt. Rend., Ser. A; 273: No. 21, 1010-12(22 Nov 1971). (In French).

The Caratheodory principle is used to adapt the second law of thermodynamics applied to continuous media in the framework of special relativity theory. (France)

21506 ASPECTS OF THE SCALAR-DOMINANCE HYPOTHESIS. Golowich, E.; Lasley, Eric; Kapila, V. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 4: No. 7, 2070-9(1 Oct 1971).

The scalar-dominance hypothesis, incorporating $\epsilon(700) - \epsilon'(1060)$ mixing, is applied to a large class of elastic, single-particle matrix elements of the energy-momentum trace operator. (auth)

21507 BETHE–SALPETER MODEL WITH RISING TRAJECTORIES. zur Linden, E. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 8A: No. 1, 164-72 (1 Mar 1972).

A model with a realistic spectrum of Regge trajectories is constructed using a phenomenological energy-dependent Bethe–Salpeter kernel. A special mechanism is used to extend the domain of validity of the O_4 and approximate O_3 symmetries which are originally present only in special cases, and thereby assures the approximate parallelism of all trajectories. (auth)

21508 EQUIVALENCE PROBLEMS IN MODELS WITH INFINITE RENORMALIZATION AND UNSTABLE PARTICLES. Scarpetta, G.; Vitiello, G. (Univ., Naples). Nuovo Cim.; 8A: No. 1, 196-210(1 Mar 1972).

The equivalence problems in two models with unstable particles and infinite mass and charge renormalizations are investigated with respect to observable effects and to the details of Hilbert-space formalism. The concept of resonance both as

a product of decay of a bare quantum and as a pure dynamical phenomenon is introduced. The equivalence conditions between the models are thus equivalence conditions for one or another description. The models are of Lee-model type with relativistic kinematics. The analysis of the resonance is made in the "point-coupling" limit (cut-off functions completely removed). (auth)

21509 SEGAL'S THEORY FOR FIELDS OF INTEGER SPIN. FIRST-ORDER EQUATIONS. Kalnay, A. J. (Instituto Venezolano de Investigaciones Cientificas, Caracas); Mac Cotrina, E. Nuovo Cim.; 8A: No. 1, 85-96(1 Mar 1972).

Segal's theory is developed by adapting it to first-order equations for Bose statistics. This is done with the purpose of applying directly to the formulations of integer-spin equations written like first-order equations to use them when these are more advantageous. The explicit form of the quantum field, its commutation rules and its equation of evolution are obtained. Particularizing these results to the case of free zero spin, the results of the usual theory are obtained which is the result to be expected for this particular case. (auth)

21510 SUMMABILITY OF ASYMPTOTIC PERTURBATION EXPANSIONS. Gunson, J.; Ng, P. H. (Univ. of Birmingham, Eng.). Nuovo Cim.; 8A: No. 1, 63-78(1 Mar 1972).

Recent studies of Lagrangian field theory have indicated that some divergent Feynman perturbation series may be Borel summable asymptotic expansions with uniquely determined sums. An alternative summation method, more suited to numerical calculations than the Borel transform, is developed and it is applied to some standard singular perturbation problems. (auth)

21511 NEW VALUE FOR THE LAMB SHIFT. Peterman, A. (CERN, Geneva). Phys. Lett.; 38B: No. 5, 330-2(6 Mar 1972).

The recent analytic value of the α^2 slope of the Dirac form factor of the free electron, from the crossed ladder diagram, is added to the contributions of the fourth order diagrams already evaluated by different workers. The sum is found to be $F_1'(0)_{total} = (\alpha^2/\pi^2)(0.4699)$. This contributes to the Lamb shift in H: $(\alpha^2/\pi^2)\alpha^5_R m\alpha^2\ 0.4699 = 0.444$ MHz. The total Lamb shift in H is then: $S_H = (2S_{\frac{1}{2}} - 2P_{\frac{1}{2}})_H = 1057.911 \pm 0.011$ MHz (s.d.), and the separation $\Delta E_H - S_H$: $(2S_{\frac{1}{2}} - 2S_{\frac{1}{2}})_H = 9911.115 \pm 0.031$ MHz (s.d.). (auth)

21512 PERSPECTIVES IN QUANTUM THEORY. ESSAYS IN HONOR OF ALFRED LANDE. Yourgrau, Wolfgang; van der Merwe, Alwyn (ed.). Cambridge, Mass.; Massachusetts Institute of Technology Press (1971). 319p. $17.50.

A compilation of essays is presented. The development of quantum theory, coexistence of waves and particles, the Einstein–Bohr box experiment, quantum mechanical distribution functions, the logic of noncommutability of quantum mechanical operators and its empirical consequences, the Lande factor of an atom, space–time geometry as an abstraction from spinor ordering, and the thermodynamics of the universe and 3°K radiation are discussed. Also quantum mechanical rate processes, statistical irreversibility and quantized wave retardation, the internal symmetries of elementary particles, hidden parameter theory and unification of external and internal motions of elementary particles, particle annihilation, and philosophical dissonances in quantum mechanics are treated. Finally, causality in physics, logical foundations in physics, classification of sciences, and causality, determinism, and probability are considered. (J.F.P.)

21513 STABILITY OF VACUUM AND LIMITING FIELDS. Migdal, A. B. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2209-24(Dec 1971). (In Russian).

A study is made of polarization of vacuum in strong static fields when bound states with energies close to that of particle formation in vacuum arise. It is shown that allowance for interaction between the particles ensures stability of vacuum since vacuum polarization leads to strong screening fields which do not permit the levels to approach the "dangerous" values. Possible physical and astrophysical consequences of such alteration of vacuum are considered. (auth)

21514 QUANTIZATION AND THE ANHARMONIC OSCILLATOR. Capri, A. Z. (Univ. of Alberta, Edmonton). Lett. Nuovo Cim.; 3: No. 9, 351-6(26 Feb 1972).

To avoid the difficulties of single-particle interpretation of the standard formulation of field theory, an alternate method of quantization is proposed which is completely equivalent to the standard quantization procedure for free fields but does not contain the harmonic generation for interaction fields. The procedure is illustrated by applying it to the anharmonic oscillator in one and l dimensions. Some results on the analyticity in the coupling constant are recovered. The limit $l \to \infty$ is also discussed. (L.B.S.)

21515 GREEN FUNCTIONS AND PERTURBATION THEORY. Silvert, William (Univ. of Kansas, Lawrence). Amer. J. Phys.; 40: No. 1, 89-91(Jan 1972).

A pedagogically useful way of deriving both stationary and time-dependent perturbation theory from the field-theoretical Hartree–Fock approximation is shown. The calculation clearly shows how the contributions of real and virtual processes differ. (auth)

21516 NONPOLYNOMIAL LAGRANGIANS, RENORMALISATION, AND GRAVITY. Lectures from the Conference on Fundamental Interactions at High Energy, Coral Gables, Florida, January 20–22, 1971. Dal Cin, Mario; Iverson, Geoffrey J.; Perlmutter, Arnold (eds.). Tracts in Mathematics and Natural Sciences. Volume 1. New York; Gordon and Breach, Science Publishers, Inc. (1971). 154p. (CONF-710106-(Vol.1)).

Ten lectures are presented in Vol. 1; abstracts are prepared for eight. Two lectures were previously abstracted in NSA. (L.B.S.)

For abstracts of individual lectures see: 21517–21522, 21541, and 21542.

21517 NON-POLYNOMIAL LAGRANGIANS. Taylor, J. G. (Univ. of Southampton, Eng.). pp 42-59 of Nonpolynomial Lagrangians, Renormalisation, and Gravity. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

The methods currently being used to solve the various problems of nonpolynomial Lagrangians are explained. The following basic problems are discussed: the rules of calculation; finiteness of the results; ambiguities; unitarity; and causality. (L.B.S.)

21518 PERTURBATION THEORY FOR A CLASS OF NON-POLYNOMIAL LAGRANGIAN FIELD THEORIES. Lehmann, H.; Pohlmeyer, K. (Univ., Hamburg). pp 60-8 of Nonpolynomial Lagrangians, Renormalisation, and Gravity. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

Recent work on nonpolynomial Lagrangian field theory is discussed with emphasis on the ambiguity problem in higher-order perturbation theory. A calculation of the second-order interacting field shows that the arbitrary parameters originate from the non-uniqueness inherent in quantizing a classical Lagrangian with singular free-field commutators. It is shown that for a class of nonpolynomial interactions the condition of minimal singularity leads to a unique definition of the superpropagator. Some results are stated for the case of a scalar field with exponential self-interaction. (L.B.S.)

21519 INFINITY SUPPRESSION AND GRAVITY THEORY. Strathdee, J. (International Centre for Theoretical Physics, Trieste, Italy). pp 80-94 of Nonpolynomial Lagrangians, Renormalisation, and Gravity. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

The problem of computing the electron mass and charge in conventional quantum electrodynamics is considered. It is pointed out that gravitational effects should become important at energies of the order $(1/K_{grav}) \approx 10^{18}$ GeV. The discussion is devoted to showing that a natural and universal cut-off should be expected at this energy. Assuming that pure lepton electrodynamics should remain valid up to this energy, a highly idealized model is considered whose role is to illustrate the way in which the nonlinear gravitational field operates to produce a cut-off. (L.B.S.)

21520 EMPIRICAL EVIDENCE FOR TENSOR MESON DOMINANCE. Renner, B. (Univ., Hamburg). pp 112-17 of Nonpolynomial Lagrangians, Renormalisation, and Gravity. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

It is shown that tensor meson dominance is compatible with the limited empirical evidence available. A few speculative connections to principles in areas of high-energy physics, such as S-channel helicity conservation and (ρ,f) exchange degeneracy, are demonstrated. (L.B.S.)

21521 s-CHANNEL HELICITY CONSERVATION AND THE STRESS TENSOR. Jones, H. F. (Imperial Coll. of Science and Tech., London). pp 118-24 of Nonpolynomial Lagrangians, Renormalisation, and Gravity. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

An example of a general connection between stress-tensorial coupling and S-channel helicity conservation is given. In particular it is shown that with certain qualifications minimal stress-tensor couplings are s-channel helicity conserving. (L.B.S.)

21522 TENSOR MESON DOMINANCE AND THE STRESS TENSOR. Raman, K. (Wesleyan Univ., Middletown, Conn.). pp 125-45 of Nonpolynomial Lagrangians, Renormalisation, and Gravity. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

Some results relating to the structure of the matrix elements of the stress tensor between simple hadron states, and how tensor mesons and scalar mesons may enter into this structure are discussed. (L.B.S.)

21523 TROUBLES IN THE EXTERNAL FIELD PROBLEM FOR INVARIANT WAVE EQUATIONS. Lectures from the Conference on Fundamental Interactions at High Energy, Coral Gables, Florida, January 20–22, 1971. Dal Cin, Mario; Iverson, Geoffrey J.; Perlmutter, Arnold (eds.). Tracts in Mathematics and Natural Sciences. Volume 4. New York; Gordon and Breach, Science Publishers, Inc. (1971). 75p. (CONF-710106-(Vol.4)).

Separate abstracts are prepared for three of the four lectures included. The other lecture was previously abstracted for NSA and appeared as CONF-710106-7. (L.B.S.)

For abstracts of individual lectures see: 21397, 21524, and 21525.

21524 INTRODUCTORY REMARKS. Wightman, A. S. (Princeton Univ., N. J.). pp 1-7 of Troubles in the External Field Problem for Invariant Wave Equations. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

Remarks are given on the problem of finding solutions to wave equations for particles in an external field. In particular, the case of rapidly decreasing fields is discussed. (L.B.S.)

21525 SOME REMARKS ON THE SUPERMULTIPLET THEORY. Iverson, G. J. (Univ. of Miami, Coral Gables, Fla.). pp 44-64 of Troubles in the External Field Problem for Invariant Wave Equations. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

Certain features of the higher-spin wave equations introduced by Kursunoglu are discussed for half-integer spin systems. The Kursunoglu equations are of the generalized Dirac form where the finite dimensional matrices are elements of the group SU(3,1) ⊗ SO(3,2). It is shown that the equations can provide a mass J^P classification of baryons. The supermultiplet arising from the [4,4] representation is discussed. The second quantization of the wave equations for generalized free fields and quantization in the Lagrangian formalism are also discussed. (L.B.S.)

21526 POSITIVE ENERGY RELATIVISTIC WAVE EQUATION. Dirac, P. A. M. (Univ. of Miami, Coral Gables, Fla.). pp 1-12 of Invited Papers. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

A relativistic wave equation is derived that is different from the usual relativistic wave equation in that only positive energy solutions are allowed. (L.B.S.)

21527 NON-CANONICAL DIMENSIONS. Wilson, Kenneth G. (Cornell Univ., Ithaca, N. Y.). pp 122-8 of Broken Scale Invariance and the Light Cone. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

The theoretical evidence for noncanonical dimension from the Thirring Model, the $\lambda\phi^6$ theory, and the $\lambda\phi^4$ theory is reviewed. (L.B.S.)

21528 ONE-DIMENSIONAL FIELD THEORY. Bender, Carl M. (Massachusetts Inst. of Tech., Cambridge). pp 275-85 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

The mathematical features of $\lambda\phi^{2N}$ field theory in one-dimensional space–time are reviewed. This model, when reformulated as a quantum-mechanical potential theory, is known as the quantized anharmonic oscillator. Topics discussed include the nature of divergent perturbation theory, the analytic structure of the energy levels, and summability techniques. Recent results on the rate of divergence of perturbation theory are emphasized. (auth)

21529 COMPLETE EXPERIMENT IN HOLOGRAPHY. Toropkov, N. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 792-6 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

The theory of a complete holographic experiment was investigated with the use of the formalism of quantum electrodynamics, insofar as photon recording is associated with a change in the number of particles. The mathematical development shows that a scalar approximation is insufficient for a single-valued determination of amplitude and phase of an interaction, provided that the averaged intensity is dependent on the polarized state of scattered and reference photons. (K.S.W.)

Gravitation and General Relativity

Refer also to abstract 21071.

21530 FACTORIZATION OF THE SOLUTIONS FOR THE NONABELIAN GAUGE FIELD EQUATIONS. Kerner, Richard (Univ., Paris). Compt. Rend., Ser. A; 273: No. 23, 1181-4 (8 Dec 1971). (In French).

Nonlinear equations for the nonabelian gauge field are considered in a Minkowskian space time. In seeking factorizable solutions, the field equations are simplified and the main nonlinear parts cancelled. It is also proved that solutions of this form have all the properties of the electromagnetic field except that they cannot be superposed in the general case. The currents corresponding to the solutions envisaged are also demonstrated to be null. (France)

21531 CURVATURE OF PHYSICAL SPACE AND THE DIFFERENCE BETWEEN GRAVITATIONAL AND INERTIAL FIELDS. Polishchuk, R. F. Zh. Eksp. Teor. Fiz.; 62: No. 1, 5-13(Jan 1972). (In Russian).

The curvature tensor of three-dimensional physical space is determined by applying the Schouten–Wagner theory of curvature of nonholonomy manifolds. The concept of nonholonomy characteristics of time and space is introduced. The effect of a gravitational field on the characteristics is considered. A classification of reference systems is presented. (auth)

21532 BODY WITH INTERNAL STRESSES IN A GRAVITATIONAL FIELD. Khrapko, R. I. (Moscow Aviation Inst.). Zh. Eksp. Teor. Fiz.; 62: No. 1, 3-4(Jan 1972). (In Russian).

A light isolated body whose world tube is nongeodesic as a result of internal stresses in the body is considered within the framework of general relativity theory. (auth)

21533 SPHERICALLY SYMMETRIC SPACETIMES IN GENERAL RELATIVITY: INVARIANT FORMULATION OF EINSTEIN'S EQUATIONS. Clark, T. G. (Chelsea Coll. of Science and Tech., London). Lett. Nuovo Cim.; 3: No. 8, 317-19(19 Feb 1972).

It is pointed out that the mass function equations for a spherically symmetric spacetime, given in co-ordinate-dependent form by Cahill and McVittie (Journ. Math. Phys. 11, 1382(1970)), can be expressed in a manifestly-invariant form. The resulting equations are then directly applicable to any energy momentum tensor, using any co-ordinate system. (L.B.S.)

21534 SPHERICALLY SYMMETRICAL GAUSSIAN SYSTEM OF COORDINATES IN GENERAL RELATIVITY. Korkina, M. P. (Dnepropetrovsk State Univ., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 8, 1247-51(Aug 1971). (In Russian).

All the possible spherically symmetrical Gaussian systems of coordinates are obtained. Two private cases of the Gaussian systems are considered. In the first case the space is analogous to the Lemaitre space, in the second—to the Kruskal space. It is shown that all the Gaussian systems of coordinates are not complete systems. (auth)

21535 MORE PRECISE CALCULATION OF LIGHT BEAM DEVIATION IN SCHWARZSCHILD GRAVITATIONAL FIELD.

Vlasov, Yu. P. (Moscow Aviation Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 150-2(1971). (In Russian).

The angle of deflection of a light beam in a Schwartzschild gravitational field was calculated and compared with the change of angular coordinates corresponding to a fixed radius-vector in relativistic and nonrelativistic approximations. (K.S.W.)

21536 VARIATIONAL FORMALISM IN RELATIVISTIC DYNAMICS OF A CONSERVATIVE CONTINUOUS MEDIUM. Minkevich, A. V.; Sokol'skii, A. A. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 70-8 (1971). (In Russian).

Using the Fock method within the framework of the Euler approach, the general variational formalism of dynamics of a conservative continuous medium was laid out. The medium was assumed to be interacting with physical fields in a Riemannian geometry of the general theory of relativity. Equations of motion of the medium were obtained. An energy-momentum tensor and moment of momentum were established based on the Noether formalism, and were related to the conservation laws. An examination was conducted for both procedures of the Lagrange problem: as functions of fixed parameters and their partial derivatives, and as functions of parameters and their covariant derivatives. (tr-auth)

21537 EQUATIONS OF MOTION OF ROTATING BODIES IN THE GENERAL THEORY OF RELATIVITY. Ryabushko, A. P. (Belorussian Inst. of Mechanization of Agriculture, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 86-95 (1971). (In Russian).

In the general theory of relativity in a post-Newtonian approximation, equations of translational and rotational motion were derived for a system of bodies which possesses intrinsic moments of momentum. The method of derivation was refined by utilizing a modification of Dirac's delta-function, which avoided the procedure of renormalizing the masses, and an energy-momentum tensor in the more general form was selected. The proposed refinement facilitates derivation of the equations of motion. The coordinate system was harmonic. The equation for translational motion agrees fully with Fock's 1955 equations. The equations obtained were compared with those of other authors. (tr-auth)

21538 PARTICLE PRODUCTION AND VACUUM POLARIZATION IN AN ANISOTROPIC GRAVITATIONAL FIELD. Zeldovich, Ya. B.; Starobinskii, A. A. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2161-75(Dec 1971). (In Russian).

Particle production and vacuum polarization of a scalar field with arbitrary mass in an external strong gravitational field with a uniform, spatially plane, nonstationary metric are considered. In the general anisotropic case finite renormalized mean values of the energy—momentum tensor are found. It is found that absence of vacuum polarization and particle production of a zero mass field occur only in the isotropic case. The behavior near the singularity is investigated. Exact asymptotics are found for the case of isotropic collapse. The mean values found for anisotropic collapse grow as t^{-4} but the contraction law may be considerably different if allowance is made for the reciprocal effect of the scalar field on the metric. The polarization operator is calculated in the first order in h for the case of a weak gravitational field. (auth)

21539 SIMULTANEITY AND THE EINSTEIN–MAXWELL FIELD. McKiernan, M. A. (Univ. of Waterloo, Ont.). J. Reine Angew. Math.; 251: 91-9(1971).

The relation $R = R + (\beta^2/2) + F^r_{[}F^r_{s]}$ is shown, where R is the curvature tensor. It is noted that the relation between the curvature tensors involves a somewhat arbitrary orientation tensor, but at most six independent components of the tensor vanish in a specific frame of reference. (J.F.P.)

21540 BEHAVIOR OF FAST PARTICLES IN THE SCHWARZSCHILD FIELD. Carmeli, M. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Lett. Nuovo Cim.; 3: No. 9, 379-83(26 Feb 1972).

The behavior of photons in a gravitational field has been suggested as a possible new experiment to test general relativity by measuring the effect of solar gravity on time delays of round-trip travel times of radar pulses transmitted from the Earth toward an inner planet. It is pointed out that the same phenomena of slow-down holds also for very fast test particles when they move in the gravitational field. It is assumed that test particles move according to the geodesic equation. (L.B.S.)

21541 STRONG GRAVITY. Isham, C. J. (Imperial Coll. of Science and Tech., London). pp 95-105 of Nonpolynomial Lagrangians, Renormalisation, and Gravity. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

The theory of strong gravity, which is concerned with gravitational interactions of hadrons with leptons, is discussed. It incorporates one massive (f) and one massless (g) 2^+ tensor meson and is constructionally the natural spin-two analog of the ρ-A mixing theory of electromagnetic interactions. The points of similarity between these two theories are given. The construction of a suitable f-g mixing term is treated. Various applications of strong gravity theory in particle physics, general relativity, and cosmology are pointed out. (L.B.S.)

21542 MIXING AND MASS IN SPIN 2 SYSTEMS. Deser, Stanley (Brandeis Univ., Waltham, Mass.). pp 106-11 of Nonpolynomial Lagrangians, Renormalisation, and Gravity. /Dal Cin, Mario (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1971).

From Conference on fundamental interactions at high energy; Coral Gables, Fla. (20 Jan 1971).

Comments are given concerning f-g mixing and its relation to normal gravitation and problems encountered in the massless limit of a single tensor field. (L.B.S.)

21543 TESTING GENERAL RELATIVITY: PROGRESS, PROBLEMS, AND PROSPECTS. Shapiro, Irwin I. (Massachusetts Inst. of Tech., Cambridge). pp 286-301 of Particles and Fields, 1971. /Melissinos, A. C. (ed.). New York; American Inst. of Physics (1971).

From Meeting on particles and fields; Rochester, N. Y. (30 Aug 1971).

A review is given of recent results from radar and radio gravity experiments to test general relativity theory, which includes retardation of radar signals, deflection of radio waves, relativistic perihelion advance of Mercury, and time variation of the gravitational constant. Prospects for improvement in these experiments are discussed. (L.B.S.)

Scattering Theory

21544 (CONF-710941-1) INFINITE HELICITY SUMS AND GENERALIZED O(1,2) EXPANSIONS. Cronstroem, C. (Jyvaskyla Univ. (Finland). Dept. of Physics. Helsinki Univ. (Finland). Dept. of Theoretical Physics). Oct 1971. 17p. Dep. NTIS (U. S. Sales Only).

From fifth conference on elementary particle theory; Pezinska Baba, Czechoslovakia (Sep 1971).

A brief review of the O(1,2) expansion formalism for power bounded multiparticle amplitudes is given and it is shown that the occurrence of infinite helicity sums in the formalism does not pose any serious convergence problem. The role of the so called nonsense terms is clarified, and it is shown that these necessarily cancel against identical terms in the O(1,2) integrals. A modified formalism in which the necessary cancellations are built in explicitly is suggested. (auth) (FINLAND)

21545 (ITF-71-67-E) INVERSE PROBLEM OF SCATTERING THEORY AND THE RIEMANN METHOD. PART I. FREE RIEMANN–GREEN FUNCTION OF THE INVERSE PROBLEM OF SCATTERING THEORY. PART II. Gugushvili, E. I.; Mentkovskii, Yu. L. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 35p. Dep. NTIS (U. S. Sales Only).

Extending the Riemann's method to the case of unbounded domains, a new rigorous approach to the inverse problem of scattering theory is developed. The proposed approach allows one to deal with the scattering of both charged and neutral particles in the framework of a universal scheme which is also suitable for treating both real and complex angular momentum cases. (auth)

21546 BACK AND FORTH WITH PARTIAL WAVES. Cirelli, R.; Pelosi, V. (Istituto Nazionale di Fisica Nucleare, Milan. Univ., Milan). Lett. Nuovo Cim.; 3: No. 8, 309-12 (19 Feb 1972).

An outline is given for examining to inverse scattering problem in order to study the generation of resonances from the dynamic content of phase shifts. (L.B.S.)

21547 ANOMALIES OF THE TRIPLE REGGE VERTEX. Jengo, R. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Lett. Nuovo Cim.; 3: No. 8, 335-8 (19 Feb 1972).

It was previously pointed out that the triple Regge vertex for inclusive interactions A + B → C + anything does not have the expected Regge behavior, if there is a pomeron $\alpha_P = 1$ coupled with B. The question of what happens if the trajectory $\alpha_{B\bar{B}}$ exchanged in the $B\bar{B}$ channel is not equal to one is considered. An attempt is made to obtain a general formula, valid for all cases. (L.B.S.)

21548 GROUP THEORETIC APPROACH TO THE NON-RELATIVISTIC N-BODY PROBLEM. Galbraith, Harold William. Philadelphia; Univ. of Pennsylvania (1971). 196p. University Microfilms Order No. 72-6151.

Thesis.

The possibility of constructing solutions to the N-particle Schrödinger equation in terms of spherical coordinates in 3N-3 dimensional space is investigated. The problem is divided into two distinct parts: kinematical and dynamical. The problem of constructing kinematic angular functions for the N-body problem, i.e., generalized spherical harmonics, by the methods of group theory is attacked. More specifically, the problem of the classification (or equivalently the construction of a complete set of commuting observables) of N-particle angular states may be viewed in the language of group theory as that of finding a "physical" reduction chain according to which the orthogonal group O_{3N-3} is reduced. The basis states which are constructed are in the form of homogeneous polynomials in the Cartesian components of suitably chosen relative vectors. These polynomials, the so-called (3N-3)-solid harmonics, are then labeled by the eigenvalues of Casimir operators of the groups of the chain $O_{3N-3} \supset \ldots \supset O_3^1 \supset O_2^1$, where O_3^1, O_2^1 are the familiar 3 and 2-dimensional rotation groups of the system about its center of mass. Beyond the requirement that orbital angular momentum operators be diagonalized by the O_{3N-3} basis, there is the physical requisite that the transformation properties under the group of particle permutations, S_N, be specified, and that the solid harmonics transform according to irreducible representations of S_N, if possible. (TSS)

21549 CLUSTER DECOMPOSITION OF VENEZIANO AMPLITUDES. Chan, Hong-mo; Hoyer, P.; Ruuskanen, P. V. (CERN, Geneva). Nucl. Phys.; B38: No. 1, 125-40(1972).

A simple general rule is given for writing down the factorized form of an N-point Veneziano amplitude when it is decomposed into several clusters separated by high energies. It is hoped that while the explicit form of the cluster vertices may be useful phenomenologically, the manner in which they are obtained may also be instructive when considering the factorization of N-point functions in general. Note that factorization along trajectories as considered here differs in meaning from that of residues at resonance poles as embodied in the operator formalism. (auth)

21550 N-REGGEON VERTEX IN THE DUAL RESONANCE MODEL. Saito, S. (Istituto Nazionale di Fisica Nucleare, Naples); Kosterlitz, J. M. Nucl. Phys.; B38: No. 1, 269-85(1972).

The manifestly gauge invariant N-Reggeon vertex Γ_N is derived from the n-particle Veneziano amplitude in the form $\langle 0|W_1 W_2 \ldots W_N|0\rangle$ by using a local projective operator W. This reduces to the standard Reggeon-particle vertex of Nambu and Fubini et al. in the spinless particle limit, and acts like a field operator of a quantum field theory. The symmetries of the vertex are discussed. Factorization is proved in a similar manner to the derivation, and a propagator which is essentially Γ_2 is introduced. The connection of this formalism to others is discussed. (auth)

21551 RESONANT STATES AND POLES OF THE SCATTERING MATRIX FOR PERTURBATIONS OF $-\Delta$. Shenk, Norman (Univ. of California, San Diego, La Jolla); Thoe, Dale. J. Math. Anal. Appl.; 37: No. 2, 467-91(Feb 1972).

It is shown that the scattering matrix S(k) has a meromorphic continuation from the positive real axis to the entire complex plane if the space dimension n is odd and to the entire logarithmic Riemann surface $\{k \neq 0: -\infty < \arg k < \infty\}$ if n is even. The relation is studied between S and outgoing solutions of the boundary value problem $(-\Delta + q - k^2)u = 0$ in Ω, $\gamma u = 0$ on Γ. In particular it is shown that a nonzero k with $-\pi < \arg k \leq \pi$ is a pole of S if and only if there exist nonzero outgoing solutions of the above relation. (J.F.P.)

21552 EXPONENTIAL APPROXIMATIONS FOR THE EVOLUTION OPERATOR. Voslamber, Dietrich (CEN, Fontenay-aux-Roses, France). J. Math. Anal. Appl.; 37: No. 2, 403-11(Feb 1972).

Approximate exponential solutions $Y \approx \exp \Omega^{(n)}$ of the operator equation $\partial Y/\partial t = i\lambda A(t)Y$ are derived. When developed in powers of λ, they agree with the perturbation expansion up to n-th order. Further, they have the following properties: they are unitary when A(t) is Hermitian, they are identical with the exact solution when A(t) commutes with its integral, $\Omega^{(n)}/\lambda$ is bounded under wide conditions when A(t) is Hermitian. Applications to physical problems are discussed. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

21553 DYNAMICS OF BOSE SYSTEMS IN ACTION-ANGLE VARIABLES. Ruggeri, G. J. (Univ. Central de Venezuela, Caracas). Physica; 56: No. 1, 121-4(15 Nov 1971).

The dynamical equations of one-dimensional Bose systems are expressed in action-angle variables through the use of the diagonal coherent-state representation. Troubles arising from the nonperiodicity of the phase variable previously used by Biswas in the same context are avoided by introducing new periodic phase variables. Even these new variables do not satisfy simple evolution equations. (auth)

21554 CONSEQUENCE OF THE GAUGE SYMMETRY BREAKDOWN IN A BOSE LIQUID. de Pasquale, F.; Tombesi, P. (Univ., Rome. CNR, Rome). Physica; 56: No. 1, 151-60(15 Nov 1971).

The aim of this paper is to derive, from an operational definition of the local superfluid density $\rho_s(k)$ previously introduced, the main properties of the "hydrodynamical limit." In this limit, as a consequence of gauge invariance, a sum rule due to Josephson is readily derived. Agreement is also found with the definition of the normal density proposed by Kehr on the basis of a microscopic expression of a two-fluid thermodynamic grand potential. (auth)

21555 VARIATIONAL MODEL FOR THE THERMODYNAMIC PROPERTIES OF A BOSE FLUID. De Michelis, C.; Reatto, L. (Univ., Milan). Nuovo Cim.; 7B: No. 1, 145-65(11 Jan 1972).

The interacting Bose fluid is studied on the basis of a variational principle for the thermodynamic potential. The Hamiltonian for a gas of noninteracting excitations, with a temperature-independent spectrum, is used as the model Hamiltonian which appears in the variational principle. The excitations are assumed to be phonons for wave vectors up to k_c and Bogolyubov excitations for $k > k_c$. Two cases are considered: in the first, the wave-vector cutoff k_c is assumed to be zero, and in the second, k_c is considered to be a variational parameter. In both cases it is found that the phase transition between the low-temperature phase with a condensate and the high-temperature normal phase is a continuous transition. This contrasts with the first-order nature of the transition found on the basis of several model Hamiltonians. (auth)

21556 THEORY OF THE LIQUID–SOLID PHASE TRANSITION IN HELIUM II. Celli, V.; Ruvalds, J. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 28: No. 9, 539-42(28 Feb 1972).

The liquid-solid phase transition of helium at low temperatures is shown to result from the instability of the roton mode. In a simple model of the roton–roton interactions, the instability arises at a finite value of the roton energy as a result of the hybridization of a single roton with a bound roton pair. Thus, this model exhibits a discontinuous jump of the soft-mode energy at the phase transition, in agreement with neutron scattering experiments. (auth)

21557 LOW-TEMPERATURE SUPERFLUID DENSITY IN A RESTRICTED GEOMETRY. Pobell, F. D. M.; Chan, H. W.; Corruccini, L. R.; (and others) (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 28: No. 9, 542-4(28 Feb 1972).

The temperature dependence of the superfluid density for liquid helium contained in a restricted geometry was studied, using fourth-sound, persistent-current, and oscillating U-tube techniques. Particular emphasis was given to the temperature range below 1 K. At the lowest temperatures the effective superfluid density becomes a linear function of temperature; this behavior is in contrast to bulk helium where a small T^4 temperature dependence is expected. (auth)

21558 WAVE PROCESSES IN FILMS OF SUPERFLUID HELIUM. Karchava, T. A.; Sanikidze, D. G. (Inst. of Cybernetics, Kiev). Zh. Eksp. Teor. Fiz.; 62: No. 1, 369-76 (Jan 1972). (In Russian).

Propagation of waves in saturated films and in thin films of helium is considered for the case when some slowing down of the normal component of the liquid occurs. It is shown that surface waves of two types exist. One is related to van der Waals interaction between the film and backing and the second to propagation of temperature oscillations and to periodic evaporation and condensation of helium. In both types of waves, both the temperature and thickness of the film oscillate. A type of wave dispersion depending on the film thickness and frequency of the propagating wave is observed. The propagation velocities and absorption coefficients of the waves are calculated. (auth)

Superconductivity

21559 (LA-DC-13299) SUPERCONDUCTIVITY OF VARIOUS TERNARY THORIUM COMPOUNDS. Giorgi, A. L.; Szklarz, E. G.; Krupka, M. C. (Los Alamos Scientific Lab., N. Mex.). [1970]. 7p. (CONF-711027-2). Dep. NTIS.

From third symposium on microdosimetry; Stresa, Italy (17 Oct 1971).

Superconductivity measurements have been made on the pseudo binary ThC/ThN system. The transition temperature (T_c) was found to increase from 3.2°K for the ThN phase to a maximum of 5.8°K at the composition $ThC_{0.78}N_{0.22}$ and then drop sharply as the composition approached the pure ThC. Using high-pressure high-temperature techniques, a thorium sesquicarbide phase crystallizing in the body-centered-cubic Pu_2C_3-type structure was prepared and found to be superconducting with a T_c of 4.1°K. Ternary sesquicarbides with the general formula $(Th_{1-x}M_x)C_{1.5}$ with M = Sc, Y, La, Lu, Er and Ho were also prepared. An increase in the T_c resulted in all cases. The highest T_c observed was 17.0°K and occurred in the yttrium–thorium sesquicarbide system at the composition $(Th_{0.3}Y_{0.7})C_{1.55}$. (auth)

21560 (LBL-433) SYNTHESIS OF LOW TEMPERATURE STABLE A15 COMPOUNDS IN THE NIOBIUM SYSTEM. Hazra, Subhas (California Univ., Berkeley. Lawrence Berkeley Lab.). Dec 1971. Contract W-7405-eng-48. 59p. Dep. NTIS. Thesis.

The A15 phases of the Nb–Ge, Nb–Ga, and Nb–Si systems were investigated. By low-temperature vapor deposition, the A15 phase boundary of NbGe and NbGa was extended toward the stoichiometric composition; the T_c onset was 15.2 and 16.5°K, respectively. The lattice parameter showed a decrease as the 3:1 composition was approached. The A15 structure was observed in the Nb–Si system for the first time. Nb_3Si transforms to tetragonal above 680°C. No high T_c has been observed so far, but some annealing methods that might lead to higher T_c are proposed. (auth)

21561 PROBLEMY SVERKHPROVODYASHCHIKH MATERIALOV. Trudy V Vsesoyuznogo Soveshchaniya po Fiziko-Khimii Metallovedeniyu i Metallofizike Sverkhprovodnikov. (Problems of Superconducting Materials. Proceedings of the 5th All-Union Conference on the Physical Chemistry, Metallurgy, and Metal Physics of Superconductors). Conference Held in Moscow, May 27–29, 1968. Chernov, A. N. (ed.). Moscow: Izdatel'stvo Nauka (1970). 232p. (CONF-680567).

Twenty-four papers are included on the problems of superconducting materials. Separate abstracts were prepared for twenty-three. (M.H.R.)

For abstracts of individual papers see: 21562–21583, and 21611.

21562 ZONAL STRUCTURE OF THE ENERGY SPECTRUM AND ITS RELATIONSHIP TO SUPERCONDUCTIVITY OF TRANSITION METALS AND ALLOYS. Nemnonov, S. A.; Kurmaev, E. Z. pp 5-38 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

Data are collected and summarized for the transition metals concerning their electron heat capacity, critical transition temperature to the superconducting state, results of theoretical calculation of density of electron states N(E), and on x-ray emission spectra, reflecting the structure of the bands of valence electrons. This combined approach allows the production of reliable information on the structure of the energy spectrum of electrons, necessary for a deep understanding of the various properties of transition metals and alloys. It is established that the energy bands for the various transition metals and alloys, at least up to electron concentrations of 7 to 7.5 el/at, have a homogeneous structure. The transition metals and alloys show a strong effect of collectivization of the valence d and s electrons (formation of a generalized conductance band). (11 figures, 72 references) (JPRS)

21563 IDENTIFICATION OF METAL COMPOUNDS OF COMPOSITION A_3B BY ELECTRONIC COMPUTER. Savitskii, E. M.; Devingtal, Yu. V.; Gribulya, V. B. pp 39-50 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

Compounds of the stoichiometric composition A_3B include superconductors with the highest transition temperature. It is known that some of these compounds are formed between low-melting and refractory components in a peritectic reaction, which makes their experimental production quite difficult. There is, therefore, interest in determination of the characteristics or criteria for the presence of such compounds. The use of recognition methods, mainly using computers, allowed certain empirical criteria both for the presence of these compounds and for methods of their formation to be found. Furthermore, these criteria allow the presence or absence of an area of homogeneity in the concentration interval to be indicated. Examples are presented of recognition of superconducting compounds by computer. (9 tables) (JPRS)

21564 THERMODYNAMICS OF SUPERCONDUCTING MATERIALS BASED ON GROUP V REFRACTORY METALS. Burylev, B. P.; Vasil'ev, V. V. pp 51-64 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The interchange energy of vanadium, niobium, and tantalum with 80 elements of the periodic table is calculated and used to produce semiquantitative data on the nature of the interaction of group V refractory metals with various metals and metalloids. The parameters of the interparticle interaction are determined from the area of immiscibility on the state diagram for the systems Nb–Sn, Nb–Zr, Nb–U, Nb–Y, Ta–Y and V–Y. The possibility is demonstrated of calculating various properties of binary and multicomponent systems based on vanadium, niobium, and tantalum: vapor pressure, density, atomic volume, diffusion coefficients, viscosity, etc. (40 references) (JPRS)

21565 PROBLEM OF METHODS OF DESCRIBING THE MAGNETIC HYSTERESIS OF RIGID SUPERCONDUCTORS. Potapov, N. N. pp 65-70 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

Problems related to the use of various physical quantities to characterize the magnetic hysteresis of solid superconductors are discussed. Results are presented from a study of the hysteresis of sintered Nb–Sn alloys in the region of the composition Nb_3Sn at 4.2°K. Experimental data are used to determine and compare quantities characterizing the hysteresis in cases of cooling of specimens to below the critical temperature in a magnetic field and with no field. The relationship of the corresponding field and energy quantities determined for these two cases is demonstrated. The value of the first critical field was 200 Oe, found by the method suggested by Prekul and Vol'kenshtein, agrees well with known results produced using other methods. (JPRS)

21566 SUPERCONDUCTING METALLIC COMPOUNDS. Savitskii, E. M.; Efimov, Yu. V. pp 71-88 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

Regularities of the change in transition temperature for metal compounds are studied as a function of type of crystal structure, degree of order of this structure, electron structure, chemical composition, and formation conditions. Influences of pressure, interstitial impurities, alloying, heat treatment, and other factors on the superconducting properties and the structure of various compounds are studied. Regularities of the change in critical temperature are studied in binary and trinary alloys based on compounds, and the characteristic features of the "composition-T_c" diagrams are discussed. The maximum critical temperatures are observed in compounds with structures such as Cr_3Si. The structure and properties of superconducting compounds can be controlled within certain limits by varying the thermodynamic factors (concentration, temperature, pressure) or by applying magnetic, radiation, and other fields. Certain possibilities for manufacture of various products of brittle superconducting compounds are noted. (6 figures, 69 references) (JPRS)

21567 X-RAY L-SPECTRA OF NIOBIUM AND THE ELECTRON STRUCTURE OF THE COMPOUND Nb_3Sn. Korsunskii, M. I.; Genkin, Ya. E.; Omarov, M. M. pp 89-91 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The L x-ray emission spectra of niobium in the compound Nb_3Sn are studied. The x-ray spectral data produced are used in forming conclusions about the electron structure of the alloy Nb_3Sn. It is established that in the region of the Fermi boundary, the influence of the d-states in the wave functions of collectivized electrons is near unity. The width of the energy zone of collectivized electrons is on the order of 7 eV, corresponding to a concentration of $\sim 1.6 \pm 0.2$ almost-free electrons per atom of the alloy. The influence of p-states in the wave functions of electrons creating local bonds is great, and there is an admixture of d-states. It is believed that this facilitates the formation of directed chain bonds between niobium atoms. (JPRS)

21568 POSSIBLE REASON FOR THE HIGH CRITICAL TEMPERATURE OF THE SUPERCONDUCTING COMPOUND $Nb_3Al_{0.8}Ce_{0.2}$. Pan, V. M.; Latysheva, V. I.; Sudovtsov, A. I.; Mel'nikov, V. I. pp 92-8 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The isotherms of the cross section of the segment of the phase-equilibria diagram of the Nb–Al–Ge system for Nb-rich alloys (up to 27.5 at.% Al and Ge) at 1700 and 1000°C are plotted. It is shown that the isomorphic compounds of Nb_3Al and Nb_2Ge form a continuous series of solid solutions at these temperatures. The form of the region of homogeneity of the phase β-$Nb_3Al_xGe_{1-x}$ is studied. It is shown that in the Nb_3Al–Nb_3Ge system (i.e., in the cross section of the Nb–Al–Ge system with a constant niobium concentration of 75 at.%) the only single-phase alloys are those with a concentration of no more than 5 to 7 at.% (the above-mentioned concentrations of Ge correspond approximately to a ternary compound with the formula $Nb_3Al_{0.8}Ge_{0.2}$). It is also shown that the critical temperature of the phase β-$Nb_3Al_xGe_{1-x}$ increases (apparently according to a parabolic law) with an increase in the Ge content in the phase under condition of retention of a high (at least stoichiometric, i.e., 25 at.%) total concentration of component B (i.e., %Al + %Ge). As soon as the total concentration of component B begins to decrease and becomes lower than the stoichiometric concentration, the critical temperature falls sharply. The form of the region of homogeneity of the phase β-$Nb_3Al_xGe_{1-x}$ determined in this work shows that the highest concentration of germanium at which stoichiometric composition of the phase is still realized (%Al + %Ge $\geq$ 25) is 5 to 7 at.%. Therefore, it is clear that, for this particular composition corresponding to the formula $Nb_3Al_{0.8}Ge_{0.2}$, the highest critical temperature should be and is observed. (20 references) (JPRS)

21569 STRUCTURE AND SUPERCONDUCTING PROPERTIES OF CAST ALLOYS OF THE NIOBIUM–TIN SYSTEM. Savitskii, E. M.; Baron, V. V.; Mikhailov, B. P. pp 99-105 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The possibility of producing ingots of niobium–tin alloy by high-frequency melting in a graphite crucible in an inert atmosphere is studied. The structure of the alloys (by macro- and microstructural analysis) and phase composition of alloys are studied; a color etching method is developed for phase determination. The possibility is established of producing ingots of niobium–tin alloy of various sizes and geometric shapes with tin contents of up to 50 wt.% with even distribution of components and a transition temperature of 17.5 to 18.0°K. (JPRS)

21570 STRUCTURE AND SUPERCONDUCTING PROPERTIES OF ALLOYS BASED ON THE COMPOUND Nb_3Sn MADE BY THE METHOD OF PHASE SUBSTITUTION IN THE SOLID–LIQUID STATE. Savitskii, E. M.; Baron, V. V.; Mikhailov, B. P. pp 112-19 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

It is shown that the low-melting phase in Nb–Sn alloys can be replaced by other superconducting alloys (Pb, Pb–Sb, Pb–Bi) which have a temperature of transition to the superconducting state from 7.1 to 8.2°K. It is shown how structure affects superconducting properties; alloys are produced that have appreciable ductility and the capacity for plastic deformation. It is found that the method of substituting the low-melting component can be used for alloys of any systems consisting of high-melting and low-melting phases which have the necessary crystallization temperature interval. (JPRS)

21571 DEVELOPMENT OF Nb_3Sn SUPERCONDUCTING MATERIAL FOR SOLENOIDS. Baranov, I. A.; Konovalov, N. T.; Kunakov, Ya. N.; Kamskii, L. Z. pp 120-3 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

It is known that three intermediate compounds — Nb_3Sn, Nb_6Sn_5 and $NbSn_2$ — are formed in Nb–Sn diffusion layers, and the regions and temperatures of phase existence have also been determined. These data were used in developing the technology of Nb_3Sn superconducting wire. Nb_3Sn superconductor was developed and produced in the form of microcable with copper coating and heat-resistant enamel. The tinning technique is worked out; the amount of tin deposited on the cable may be regulated up to 30 wt.%. The critical temperature and critical current are measured in multiplier cable heat treated at 960 ± 10°C. (JPRS)

21572 VACUUM INSTALLATION FOR PRODUCTION OF Nb_3Sn BY CONTINUOUS METHOD BY DIFFUSION OF TIN IN NIOBIUM BASE FROM MELT. Krainskii, I. S.; Mazokhin, S. S.; Sokolov, V. I.; Shchegolev, I. F.; Enman, V. K. pp 124-30 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

A constructive description is presented of an installation in which a continuous process of formation of a thin layer of the compound Nb_3Sn on a niobium profile (strip, wire, cord) of great length is performed by drawing through a bath of melted tin at 950 to 1,050°C in a vacuum at a predetermined drawing rate. If the drawing rate is increased or the bath temperature is decreased, the installation can be used to produce a niobium shape coated with a thin layer of tin without formation of the compound Nb_3Sn, which is formed upon later heat treatment. The installation, which can produce a high vacuum and can provide a wide range of speeds (0.72 to 570 m/hr) and an adjustable tin melt temperature, allows the study of the influence of various factors on the critical characteristics of superconductors of the compound Nb_3Sn to be performed. Critical characteristics of this first experimental specimen of superconducting strip produced on the installation are presented. (JPRS)

21573 INFLUENCE OF PRESSURE ON THE EQUILIBRIUM BETWEEN α, β, AND ω PHASES IN SYSTEMS BASED ON TITANIUM AND ZIRCONIUM. Aptekar, I. L.; Ponyatovskii, E. G. pp 131-40 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The thermodynamic potentials of the α, β, and ω modifications of Ti and Zr are calculated. The energy, entropy, and transition volume values included in the phase-equilibrium equations are assumed independent of temperature and pressure and are determined using handbook data and data on the P–T diagrams of Ti and Zr. The relationships produced satisfactorily describe the P–T diagrams of these elements. It is demonstrated that the ω phase in alloys of Ti and Zr is a solid solution of the alloying component in the high-pressure ω modification of Ti and Zr. Certain possible types of stable and metastable state diagrams of metal systems based on Ti and Zr are studied in the approximation of ideal solutions, considering the ω phase, and their evolution is traced as pressure is applied. (JPRS)

21574 INFLUENCE OF HIGH-PRESSURE TREATMENT ON PHASE COMPOSITION AND SUPERCONDUCTING PROPERTIES OF ZIRCONIUM–NIOBIUM ALLOYS. Rabin'kin, A. G.; Klishanova, L. A.; Pronina, L. N. pp 141-7 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

Results are presented from a study of the transition temperature, critical fields, and phase composition of alloys of zirconium with 2 to 40 at.% Nb after they are subjected to high hydrostatic pressure (35 to 65 kbar). It is demonstrated, that, as for pure Zr, the application of high pressure results in formation of an ω phase in the alloys with 2 to 30 at.% Nb, whereas annealing fixes the ω phase only in alloys with 7 to 10 at.% Nb. The high-pressure ω phase formed is retained in the specimens after pressure removal, its quantity being significantly increased in alloys with 7 to 10 at.% Nb. Alloying of Zr with niobium decreases the pressure at which the ω phase develops in comparison to pure Zr. In all cases, the formation of the high-pressure ω phase or the increase in its quantity causes a reduction in T_c, an expansion of the temperature interval over which the transition to the superconducting state occurs, and a decrease in the value of H_{c2}. (JPRS)

21575 STRUCTURE AND SUPERCONDUCTING PROPERTIES OF SINGLE CRYSTALS OF NIOBIUM WITH 5 AND 10 PERCENT ZIRCONIUM. Savitskii, E. M.; Myzenkova, L. F.; Baron, V. V.; Martynova, L. F. pp 148-55 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The structure of single crystals of the alloys of niobium with 5 and 10 wt.% Zr produced by the method of cathode-ray zone melting is studied. Data are presented on the distribution of zirconium and interstitial impurities over the length of a monocrystalline bar. The transition temperature is measured. For the alloy niobium–5% Zr, T_c = 10°K; for the alloy niobium–10% Zr, T_c = 10.5°K. Magnetization curves of specimens with various crystallographic orientation are measured. (JPRS)

21576 RESISTIVITY OF ZIRCONIUM–TANTALUM ALLOYS UNDER HYDROSTATIC PRESSURE. Fedotov, L. N.; Kirshenina, I. I.; Zarubina, O. A. pp 156-60 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The dependence of resistivity on hydrostatic pressure up to 15 kbar is studied for alloys of Zr with 1.84 and 2.7 at.% Ta, near the $\alpha \rightarrow \beta$ transition boundary. In annealed specimens of the alloys, a change in the slope of the R(P) curves was observed in the 4 to 6 kbar area for the alloy Zr–2.7 at.% Ta and at 8 to 10 kbar for the alloy Zr–1.84 at.% Ta. A decrease in resistance after removal of pressure in comparison with the initial value was noted both for hardened and for annealed specimens of Zr–Ta alloys, which is related to the formation of the ω phase. The results produced are compared with the results of measurement of R(P) for Ti–Nb alloys. (JPRS)

21577 SUPERCONDUCTING VANADIUM–TITANIUM ALLOYS DOPED WITH HAFNIUM AND RHENIUM. Baron, V. V.; Efimov, Yu. V. pp 161-5 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The influence of hafnium and rhenium (up to 10 at.%) individually on the superconducting and mechanical properties of the equiatomic alloy of vanadium and titanium is studied. The alloying elements were introduced for titanium. Alloying causes an increase in hardness and strength of the alloys, but the superconducting characteristics are reduced. However, with a content of up to 1 at.% Hf or 5 at.% Re in trinary alloys, high technological properties for cold deformation were established. These alloys still have high superconducting properties (T_c = 7 to 8°K; critical current density at 4.2°K and 26 kOe reaches 1.5×10^4 A/cm^2). (JPRS)

21578 SCREENING PROPERTIES OF ALLOYS IN THE NIOBIUM–TITANIUM SYSTEM. Bychkova, M. I.; Kozlova, N. D.; Lysenko, E. N.; (and others). pp 166-72 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The distribution of the magnetic field in superconducting magnets was studied for quantum paramagnetic amplifiers using screening plates of niobium–titanium alloy. It was shown that shields of NT-1 alloy can partially screen a field and significantly improve its homogeneity. With a magnetic field intensity of 4,000 Oe, a homogeneity of 10^{-3} was produced in a volume of $5 \times 8 \times 120$ mm. (JPRS)

21579 INFLUENCE OF NIOBIUM ON SUPERCONDUCTING PROPERTIES OF AN EQUIATOMIC ALLOY OF VANADIUM WITH TITANIUM. Efimov, Yu. V.; Baron, V. V. pp 173-7 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The influence of niobium (up to 10 at.%) on the structure and properties (hardness, strength, ductility, transition temperature, critical current) of the alloy of vanadium with 50 at.% Ti was studied. The trinary alloys are single-phase solid solutions with body-centered cubic lattice. The lattice period changes from 3.138 to 3.116 A at 10 at.% Nb. Alloying with niobium increases the hardness and the strength of the binary alloy. The ductility of cold deformed wire remains practically unchanged (δ = 2 to 3%). T_c is decreased from 7.8 to 7.1°K. A sharp decrease in the critical current of cold deformed wire is observed with niobium contents of over 0.5 at.%. With lower niobium content (up to 0.5 at.%) the alloys have good technological properties and sufficiently high superconducting characteristics. (JPRS)

21580 VANADIUM–SCANDIUM AND NIOBIUM–SCANDIUM SYSTEMS AND THEIR SUPERCONDUCTING PROPERTIES. Savitskii, E. M.; Baron, V. V.; Naumkin, O. P.; Efimov, Yu. V. pp 178-86 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

Taking characteristic experimental and literature data as a basis, the principles are considered that govern the change in T_c of superconducting alloys in simple eutectic systems of transition and nontransition metals, and also in the eutectic segment of phase diagrams of binary systems with the formation of intermediate compounds. "T_c composition" diagrams are presented for binary systems of vanadium and niobium with scandium, as well as the phase diagrams of these systems. In alloys of superconducting systems of the eutectic type, superconductivity is observed both in the case of alloying of two superconductors and in the case of alloying of a superconductor with a "normal" element. The T_c of the superconducting element goes up or down as the second component is dissolved within the limits of the region of homogeneity of the solid solution. In two-phase eutectic mixtures, the T_c of each of the superconducting phases varies along a nearly horizontal straight line as the composition of the alloys changes. (25 references) (JPRS)

21581 ELECTRON-BEAM MELTING AND DEFORMATION OF SUPERCONDUCTING NIOBIUM–ZIRCONIUM ALLOYS UNDER INDUSTRIAL CONDITIONS. Savitskii, E. M.; Baron, V. V.; Frolov, V. A.; (and others). pp 187-92 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

Modes for production of ingots 90 mm in diameter weighing up to 45 kg in a cathode-ray furnace by double vacuum remelting, and modes of hot-pressing of ingots into bars 50 mm in diameter and forging of the pressed bars to diameters of 18 to 20 mm were developed under industrial conditions for alloys of niobium with zirconium. Wire 0.2 mm in diameter was produced from the bars manufactured by cathode-ray melting, hot pressing, and forging; the mechanical and superconducting properties of the wires are measured. (16 references) (JPRS)

21582 TECHNOLOGICAL AND SUPERCONDUCTING PROPERTIES OF 60T ALLOY. Baikov, A. I.; Kuznetsova, M. I.; Shadskii, D. V.; (and others). pp 193-202 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

The technological superconducting properties of 60T (Nb–60 at.% Ti) alloy are dealt with. It is shown how the mechanical properties depend on the degree of cold deformation and the diameter of the wire. The mechanism of deformation of the alloy at high temperatures is considered. It is found that the high plastic properties of the alloy permit cold drawing of wire at a rate of 100 m/min. An investigation is made of the effect that intermediate annealing and quenching as well as final annealing have on the critical current density as a function of the external magnetic field. (JPRS)

21583 ELECTROLYTIC NIOBIUM COATING OF COMPLEX-SHAPE PARTS. Savitskii, E. M.; Mikhailov, B. P.; Baron, V. V. pp 203-8 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

A method is developed for electrolytic deposition of superconductive coatings of niobium on articles of nonsuperconducting material (copper, brass, iron) of various sizes and shapes. A study is made of the effect which conditions of electrolysis have on the structure, uniformity, thickness, purity and superconducting parameters of the niobium coating. It is found that uniformly thick niobium superconducting coatings can be electrolytically deposited (on articles of various sizes and configurations) with a temperature of transition to the superconducting state of about 8.9 to 9.0°K. (JPRS)

21584 EXPERIMENTAL INVESTIGATION OF CURRENT DISTRIBUTION IN COMPOSITE SUPERCONDUCTORS. Sychev, V. V.; Al'tov, V. A. (Inst. of High Temperature, Moscow). Dokl. Akad. Nauk SSSR; 199: No. 4, 817-20(1 Aug 1971). (In Russian).

Under the conditions of current division in a composite conductor between the superconductor and the supporting backing, the resistive state is found primarily. Equations that describe this condition are discussed. The experimental approach used a 10- to 15-cm long sample of the composite conductor wound on a plastic body 2.5 cm in diameter in such a way that heat exchange with surrounding liquid helium is facilitated. The sample is placed within a superconducting solenoid, the source of the external magnetic field. Electric current is passed through the sample and gradually increased until the critical current is reached. Volt–ampere characteristics are measured at several values of the external magnetic field. (K.S.W.)

21585 MODEL HAMILTONIAN OF THE THEORY OF SUPERCONDUCTIVITY. Petrina, D. Ya.; Yatsishin, V. P. (Inst. of Theoretical Physics, Moscow). Teor. Mat. Fiz.; 10: No. 2, 283-300(Feb 1972). (In Russian).

The model Hamiltonian of the theory of superconductivity in infinite volume is investigated, and its spectrum is studied thoroughly. The grand partition function is determined, the equation of state is found, and the existence of the phase transition from the normal to the superconductive state is proved. It is proved also that the chain of equations for the Green functions of the model Hamiltonian possesses two solutions at $V = \infty$: the free Green functions and the Green functions of the approximating Hamiltonian. (auth)

21586 PHOTON MASS AND THE KUNZ EXPERIMENTS ON THE PHOTOELECTRIC EFFECT WITH SUPERCONDUCTING Pb. Vigier, J. P. (Institut Henri Poincare, Paris). Compt. Rend., Ser. B; 273: No. 23, 993-6(8 Dec 1971). (In French).

A bare mass is introduced for photons ($M_0 \leq 10^{-49}$g) and the photons penetrating into a superconductor are subsequently predicted to gather significant effective mass ($M_e = e^2n/m$), transforming an incident plane wave into a vanishing wave. The recent Kunz observations concerning thin films of superconducting Pb are explained by the fact that the incident photons remain at the surface (where the energy gap is narrower). These observations differ by more than an order of magnitude from the BCS-corrected Einstein predictions. (France)

21587 SPIN WAVES AND THE BCS MODEL. Wehrl, A. (CERN, Geneva). Commun. Math. Phys.; 23: No. 4, 319-42 (1971).

The behavior of the BCS model in the limit of infinitely many degrees of freedom is discussed. A new limiting procedure, based on spin waves, is proposed, by which the usual convergence difficulties can be overcome. (auth)

21588 FUNCTIONAL INTEGRATION METHOD IN THE THEORY OF SUPERCONDUCTIVITY. Svidzinskii, A. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Teor. Mat. Fiz.; 9: No. 2, 273-90(Nov 1971). (In Russian).

The exact representation of the statistical sum for a superconductor is given in terms of the functional integral. The theory is used to describe the fluctuation effects in superconductors above the critical temperature. (auth)

21589 EFFECT OF SUPERCONDUCTIVITY ON THE FORMATION OF LOCALIZED MAGNETIC MOMENTS. Roessler, J.; Kiwi, M. (Univ. of Chile, Santiago). Phys. Lett.; 38A: No. 5, 371-2(28 Feb 1972).

The effect of the superconducting state on the formation of localized moments is investigated. It is shown that the magnetic region is slightly reduced relative to the normal state: a quantitative expression for this reduction is given. (auth)

21590 PARAMAGNETIC EFFECTS ON FLUCTUATION-INDUCED DIAMAGNETISM IN SUPERCONDUCTORS. Leung, M. C. (Univ. of Toronto). Phys. Lett.; 38A: No. 5, 357-9 (28 Feb 1972).

The effects of Pauli spin paramagnetism on the fluctuation-induced diamagnetism are studied in superconductors with arbitrary scattering lengths. Including these effects, $(M(T_c) - M_0)/\sqrt{HT_c}$ is no longer a universal function of HT_c^{-2} and $(1 - T/T_c)$ even for pure superconductors. (auth)

21591 CURRENT-VOLTAGE CHARACTERISTICS OF TYPE-II SUPERCONDUCTORS. Sherrill, M. D.; Payne, J. E. (Clemson Univ., S. C.). Phys. Lett.; 38A: No. 5, 313-14(28 Feb 1972).

For a wide range of samples and conditions, the I–V characteristic of Type-II superconductors fits the expression $V \propto (I - I_p)^2 (I - \alpha I_p)^{-1}$. The initial nonlinearity is attributed to the fact that the fluxons do not move with uniform velocity. (auth)

21592 UPPER CRITICAL FIELDS OF Nb_xGa_{1-x}: A BINARY HIGH-TEMPERATURE SUPERCONDUCTOR. Foner, S. (Massachusetts Inst. of Tech., Cambridge); McNiff, E. J. Jr.; Webb, G. W.; (and others). Phys. Lett.; 38A: No. 5, 323-4(28 Feb 1972).

The upper critical fields, H_{c2}, of several Nb_xGa_{1-x} alloys with values of T_c from 13.3 to 20.2°K were measured at temperatures from 4.2 to 20.4°K with dc and pulsed magnet fields. For the highest T_c material, $H_{c2}(4.2°K) = 340$ kG. The data are consistent with almost complete suppression of Pauli paramagnetic limiting. Comparisons with other high-T_c materials, Nb_3Al and NbAlGe, are presented. (auth)

21593 ANISOTROPY OF THE SUPERCONDUCTING ENERGY GAP IN ALUMINUM BY MICROWAVE ULTRASONICS. Hughes, E.; Meredith, D. J.; Dobbs, E. R. (Univ. of Lancaster, Eng.). Phys. Lett.; 38A: No. 5, 325-6(28 Feb 1972).

Measurements of the absorption of 9-GHz compressional waves in aluminum crystals along the [100], [110], and [111] directions show that the mean squared anisotropy $\langle a^2 \rangle$ of the superconducting energy gap is 0.011 ± 0.002. (auth)

21594 SUPERCONDUCTING NIOBIUM TE_{011} MODE CAVITIES WITH HIGH CRITICAL MAGNETIC FIELD AND HIGH Q VALUE. Diepers, H.; Martens, H. (Siemens Research Labs., Erlangen, Ger.). Phys. Lett.; 38A: No. 5, 337-8(28 Feb 1972).

A niobium TE_{011} X-band cavity that had no heat treatment, but had only been electropolished and provided with an anodic oxide film, showed a Q value of 2.4×10^{10} just below a critical magnetic flux density of 118 mT. No degradation was observed after exposure of the cavity to air. (auth)

21595 SUPERCONDUCTING TRANSITION TEMPERATURE AND MAGNETIC SUSCEPTIBILITY OF POLYCRYSTALLINE α-URANIUM UNDER PRESSURE. Maple, M. B.; Wohlleben, D. (Univ. of California, San Diego, La Jolla). Phys. Lett.; 38A: No. 5, 351-2(28 Feb 1972).

The superconducting transition temperature of polycrystalline α-uranium drops drastically at high pressure, from 2.1°K near 10 kbar to less than 0.35°K at 90 kbar. The room-temperature magnetic susceptibility increases with pressure between 0 and 16 kbar at only one fourth the rate of the electronic specific heat coefficient. (auth)

21596 SINGULARITIES IN THE MAGNETIC FIELD MAP OF TYPE-II PURE SUPERCONDUCTORS. Delrieu, J. M. (CEN de Saclay, Gif-sur-Yvette, France). J. Low Temp. Phys.; 6: No. 3-4, 197-219(Feb 1972).

The magnetic field distribution in pure type-II superconductors is calculated in the limit of a magnetization $4\pi M$, small compared with the induction B, i.e., at low temperature in nearly the whole magnetic field region between H_{c2} and H_{c1}. Because the Ginsburg–Landau equations are invalid in this case, a magnetic field distribution is found that has no simple, local relation with the square of the order parameter $|\Delta(r)|^2$ as is the case near T_c. At $T = 0$ and very near to H_{c2}, the magnetic field map has two singularities at the maximum field H_V and minimum field H_m. These singularities have a conical shape, instead of the parabolic shape found near T_c. A finite temperature derivative of these fields $dH_V/dT = -dH_m/dT \neq 0$ at $T = 0$ is found in the limit $H = H_{c2}$; this result is in agreement with those of Kung (Phys. Rev. Lett. 15: 1006 (1970)). Results are compared with the intensity of Bragg lines of neutron diffraction found by Cribier, Simon, and Thorel. The amplitude of variation of the magnetic field is 5.3 times the magnetization at $T = 0$ near H_{c2}. (auth)

21597 PROXIMITY EFFECT IN Cu/Nb/Cu SANDWICHES, RELATED TO THEIR FLUX-FLOW PROPERTIES. Thys, W.; Bouwen, A.; Deprez, E.; Bruynseraede, Y.; Van Gerven, L. (Univ., Louvain, Belgium). J. Low Temp. Phys.; 6: No. 3-4, 257-73(Feb 1972).

When a normal and a superconducting metal are joined together, superconducting electron pairs penetrate in the normal metal, while in the superconductor their number is reduced. Starting from the flux-flow properties in a perpendicular magnetic field, this proximity effect was studied in Cu/Nb/Cu sandwiches. The decrease of the force density in the vortex lattice, obtained by applying a pinning model, is studied systematically as a function of the thickness of the copper coating and is interpreted as a decrease of the spreading of the electromagnetic field associated with a vortex at the Cu/Nb interfaces. The results are in qualitative agreement with the finite range of the pair potential in the normal metal, described by de Gennes. This range is temperature-independent within the accuracy of the experimental data. (auth)

21598 MEISSNER SHIELDING CURRENTS AND MAGNETIC FLUX PENETRATION IN THIN-FILM SUPERCONDUCTORS. Huebener, R. P. (Argonne National Lab., Ill.); Kampwirth, R. T.; Celm, John R. J. Low Temp. Phys.; 6: No. 3-4, 275-85(Feb 1972).

The magnetic flux penetration at 4.2°K into superconducting lead films of about 4 μm thickness was observed using a high-resolution magneto-optical technique. The specimens had the shape of small squares or long strips. In an increasing magnetic field, it was found that magnetic flux starts to penetrate into the bulk of the specimens in the form of flux tubes containing about 60 flux quanta. For the samples with the strip geometry, the magnetic field H^*, at which flux penetration into the bulk sets in, was investigated in the presence of an external electrical current I along the strip superimposed on the Meissner shielding currents. The field H^* was found to decrease linearly with increasing transport current I. The magnetic field near a long superconducting cylinder in the presence of both a transverse applied magnetic field and an applied electrical current parallel to the cylinder axis was calculated. The calculation is valid for a cylinder of elliptical cross section, which approximates a long, flat strip. The experimental observations for the slope $\partial H^*/\partial I$ are in good agreement with the calculations. (auth)

21599 MAGNETIC FIELD EFFECTS ON THE ELECTRICAL CONDUCTIVITY DUE TO FLUCTUATIONS OF THE SUPERCONDUCTING ORDER PARAMETER ABOVE T_c. Aomine, T.; Rinderer, L. (Univ., Lausanne, Switzerland). J. Low Temp. Phys.; 6: No. 3-4, 323-44(Feb 1972).

The electrical conductivity above the transition temperature T_c due to fluctuations of the superconducting order parameter was measured in aluminum films in the presence of a magnetic field (parallel and perpendicular to the film surface), as well as in the absence of a magnetic field. It was found, in particular from the results in a perpendicular magnetic field, that the Aslamazov–Larkin theory (AL) and its extension can be applied for temperatures close to T_c. A deviation from the theoretical linear relation (AL) $\sigma_n/\sigma'(T) \sim \ln(T/T_c)$ in zero and parallel fields might be explained in terms of the Maki–Thompson model (MT), which is consistent with previous experiments in Al films. However, the transition width due to fluctuations in a perpendicular magnetic field is not always enhanced, contrary to the prediction of the MT model. Even in the cases in which they are enhanced, the transition width is smaller than the value predicted by the MT model. (auth)

21600 MEASUREMENT OF THE FLUX-FLOW VELOCITY IN SUPERCONDUCTING FILMS BY A TIME-OF-FLIGHT METHOD. Kaugerts, Juris; Meissner, Hans (Stevens Inst. of Tech., Hoboken, N. J.). J. Low Temp. Phys.; 6: No. 3-4, 345-55(Feb 1972).

Flux was pulsed in on the left side of a superconducting film with a transport current present. The current moved the flux tubes to the right, where their arrival was sensed with a movable

pickup coil. The velocity was defined by the slope of a plot of distance vs arrival time. Velocities of 1 to 3×10^5 cm/sec for the first onset and of 0.5 to 2.7×10^5 cm/sec for the maximum of the flux field were measured. The total amount of flux decreased approximately linearly with distance traveled. (auth)

21601 FIRST- AND SECOND-ORDER SUPERCONDUCTING PHASE TRANSITIONS OF TIN WHISKERS IN A MAGNETIC FIELD. McLachlan, D. S. (Univ. of Witwatersrand, Johannesburg). J. Low Temp. Phys.; 6: No. 3-4, 385-95(Feb 1972).

Using a sensitive inductance technique, first- and second-order phase transitions in tin (type I) whiskers were observed in both parallel and perpendicular magnetic fields. For T much less than T_c, the samples exhibited considerable superheating and supercooling, from which values of the Ginzburg–Landau parameter κ were calculated. However, these values are not as low as those obtained for single spheres (diameters 10 to 30 μ), probably due to mean free path and size effects. Close to the transition temperature, it is observed that the hysteresis vanishes, indicating the onset of a second-order phase transition. Good qualitative agreement between these results and theoretical predictions based on the Ginzburg–Landau theory are obtained. Size effects on the ratio $H_{c3}/H_{c2} \equiv H_{sc}/H_{c2}$ are clearly illustrated. (auth)

21602 SUPERCURRENT TUNNELING JUNCTIONS WITH TELLURIUM BARRIERS. Seto, John; Van Duzer, Theodore (Univ. of California, Berkeley). Appl. Phys. Lett.; 19: No. 11, 488-91(1 Dec 1971).

Uniformly distributed supercurrents were observed in Josephson-like junctions using tellurium barriers with thicknesses up to 800 Å. Dependences of the maximum zero-voltage current on temperature and thicknesses are different from those of the normal-metal and oxide-barrier junctions. Typical junction resistances are comparable with those of oxide-barrier junctions. (auth)

21603 INVESTIGATION OF MICROWAVE-INDUCED dc VOLTAGES ACROSS UNBIASED JOSEPHSON TUNNEL JUNCTIONS. Chen, J. T.; Todd, R. J.; Kim, Y. W. (Wayne State Univ., Detroit). Phys. Rev., B; 5: No. 5, 1843-9(1 Mar 1972).

The power dependence of the microwave-induced dc voltages across "unbiased" Pb/Pb oxide/Pb Josephson tunnel junctions was studied and a systematic dependence found. It was also found that the Josephson effect in the form of induced quantum voltages was observable in a large dc magnetic field as high as 0.5 kG, about one-half of the H_{c2} of the superconducting Pb film. (auth)

21604 PRECIPITATES AND FLUXOID PINNING IN A SUPERCONDUCTING Nb-Hf ALLOY. Koch, C. C.; Carpenter, R. W. (Oak Ridge National Lab., Tenn.). Phil. Mag.; 25: No. 2, 303-20(Feb 1972).

The relationship between superconducting fluxoid pinning and precipitate dispersion was investigated in a high-field type II superconducting alloy. The alloy, Nb–38 at. % Hf, is a bcc solid solution above 1200°C; at lower temperatures the equilibrium structure is two-phase: bcc β and Hf-rich hcp α. The quenched alloy was aged at 600°C. The changes in microstructure during aging were examined by transmission electron microscopy. The attendant changes in superconducting properties—transition temperature (T_c) and critical flux gradient (dB/dr)—were measured by an ac susceptibility technique. It was found that precipitation at 600°C proceeds by the formation and growth of strained, partially coherent particles in the bcc matrix termed transition alpha, α_t. Particle size measurements indicated that growth of α_t follows a $t^{\frac{1}{3}}$ coarsening law after times not longer than ~0.5 hr. Transition temperature measurements substantiate this finding. Measurements of dB/dr showed little change from the quenched solution behavior for short aging times. This was attributed to the precipitate size being appreciably less than the calculated fluxoid core diameter. At longer times, a broad peak in dB/dr developed at a particular value of external field H. Following its initial appearance, the peak moved to lower values of H with further particle growth. Comparison of calculated fluxoid spacing at peak field with average particle spacing calculated from measurements on the micrographs indicated a one-to-one correspondence within the experimental limits. An approximate calculation of the point fluxoid pinning force was made from the bulk pinning force and the results are compared to theoretical predictions. (auth)

21605 LATTICE RESOLUTION STUDIES OF METAL CHALCOGENIDES AND THEIR SUPERCONDUCTING ORGANO-METALLIC DERIVATIVES. Thomas, J. M.; Evans, E. L.; Bach, B.; Jenkins, J. L. (University Coll. of Wales, Aberystwyth). Nature (London) Phys. Sci.; 235: No. 59, 126-7(14 Feb 1972).

Direct electron-microscope evidence was obtained for, and estimates made of, the lattice expansion that occurs when organic molecules are incorporated into the van der Waals gap of layered solids such as the metal dichalcogenides $NbSe_2$ and TaS_2. Organic molecules studied included pyridine, ethylenediamine, diethylamine, and triethylamine. The resulting complexes have sandwich structures and possess technologically attractive anisotropic superconducting properties. The band structure of the parent matrix is considered to be of crucial importance in the case of formation stability and structure of the intercalates, and the structures of $NbSe_2$ and TaS_2 are detailed. The van der Waals gap was found to ~0.3 nm in both compounds. In TeS_2 (pyridine)$_{0.5}$ the average interlayer spacing was 1.01 ± 0.02 nm; for TaS_2 (ethylene diamine)$_{0.2+0.1}$ values obtained were 0.98, 0.94, and 0.82 nm; for TaS_2 (triethylamine)$_{0.5}$ 1.00, 0.97, and 0.90 nm; and for TaS_2 (diethylamine)$_{0.5}$ 1.00 and 0.83 nm. The intercalation compounds of $NbSe_2$ examined showed spacings essentially indistinguishable from the parent material, probably because of decomposition in the electron beam, except for $NbSe_2$ (diethylamine)$_{0.5}$ which showed spacings of 1.03, 0.92, and 0.67 nm. It seems likely that the magnitude of the expansion (0.4 nm in the case of TaS_2 (pyridine)$_{0.5}$) is attributable to the positioning of the aromatic molecule parallel to the layer planes. (UK)

21606 FIELD PENETRATION INTO TYPE I SUPERCONDUCTING CYLINDERS. Olafsson, R.; Allen, J. F. (St. Andrews Univ., Scotland). J. Phys., F (London); 2: No. 1, 123-32(Jan 1972).

Magneto-optical and powder methods were used to observe the pattern of magnetic field penetration on the top surface of short cylinders of indium and tin when the field was applied parallel to the cylinder axis. The normal/superconducting-state phase boundary, the variation of the average field distribution in the cylinder, and the field distribution outside it were computed numerically. Together with the experimental results, the computations explain the coarse structure of the field penetration. They also show that the fine intermediate-state structure in the penetration annulus can be described by Landau's unbranched model of the intermediate state, suitably modified. The magnetic moment and the average magnetic induction in the cylinders were derived from the computations. (auth)

21607 CRITICAL SUPERCURRENTS AND THE PINNING OF VORTICES IN COMMERCIAL Nb–60 AT. PERCENT Ti. Hampshire, R. G.; Taylor, M. T. (Central Electricy Research Labs., Leatherhead, Eng.). J. Phys., F (London); 2: No. 1, 89-106(Jan 1972).

Heavily cold worked Nb–60 at. % Ti wires were studied. The wires had previously been heat-treated and characterized by electron microscopy (Neal et al., 1971). The critical supercurrents were measured as a function of applied magnetic field at temperatures between 4.2°K and the transition temperature, and interpreted in terms of the pinning force per unit volume on the vortex lattice. Empirically, the pinning force is given by $F_p = f(b)B_{c2}^n$ ($2 \lesssim n \lesssim 2.3$), where b is the reduced field B/B_{c2} and f(b) depends on the particular heat treatment but not on the temperature at which the critical current is measured. Present pinning theories are reviewed but, as none account satisfactorily for the results, a simple model based on pinning by the cell walls of the defect structure was developed. It depends upon the Ginsburg–Landau parameter being enhanced in the cell walls and fits the data for the material given the optimum heat treatment very well. It is suggested that the other heat treatments produced cell walls with a different internal structure such that the basic pinning interaction and hence f(b) and n are different. (auth)

21608 ELECTRON–ELECTRON INTERACTIONS IN SUPERCONDUCTORS. Lancashire, D. C. (Cavendish Lab., Cambridge, Eng.). J. Phys., F (London); 2: No. 1, 107-14(Jan 1972).

The nature of quasi-particle decay rates caused by electron–electron scattering in type I superconductors is investigated and found to be of comparable magnitude to phonon decay in some metals, for example aluminum. Its effect on the tunnelling density of states is also examined. (auth)

21609 LOW TEMPERATURE PROPERTIES OF METALLIC AND NONMETALLIC MATERIALS FOR SUPERCONDUCTING AND LOW TEMPERATURE MAGNETS. Brechna, H. (Nuclear Research Center, Karlsruhe, Ger.). KFK Nachr.; 3: No. 2, 31-40(1971). (In German).

Problems and recent developments of superconductors are reviewed. Mechanical properties such as elastic constants, compressibility, and sound velocity in cubic crystals are pertinent. The importance of plastic properties exemplified by flow limits

and tensile limits, and of dynamic properties such as elongation and fatigue phenomena are discussed. Families of curves portray magnetization characteristics, electric and thermal conductivity of Nb–Ti, Al, and Cu alloys, and special artificial resins. (K.S.W.)

21610 RESISTIVITY RATIO OF NIOBIUM SUPERCONDUCTING CAVITIES. Garwin, E. L.; Rabinowitz, Mario (Stanford Univ., Calif.). Appl. Phys. Lett.; 20: No. 4, 154-6(15 Feb 1972).

Resistivity measurements have been made on Nb cavities, as well as on Pb and Cu, at 296, 77, and 4.2°K by means of a contactless induced-current method. For superconductors, a constant magnetic field drives the material normal below the transition temperature. These measurements provide a simple means for initial material evaluation as well as a direct means of monitoring the effects of material parameters (purity, heat treatment, gas incorporation, etc.) on the electron mean free path. Approximate determinations of H_c, H_{c1}, and H_{c2} can also be derived from these measurements. Normal-state thermal conductivity and the Ginzburg–Landau parameter κ are calculated from the resistivity measurements. (auth)

Equipment and Devices

Refer also to abstracts 20524, 20986, and 21578.

21611 SUPERCONDUCTING MAGNETS FOR QUANTUM PARAMAGNETIC AMPLIFIERS. Baron, V. V.; Demidenko, T. F.; Klimov, S. I.; Savitskii, E. M.; Turevskii, V. M. pp 209-15 of Problemy Sverkhprovodyashchikh Materialov. /Chernov, A. N. (ed.). Moscow; Izdatel'stvo Nauka (1970). (In Russian).

From fifth All-Union conference on the physical chemistry, metallurgy, and metal physics of superconductors; Moscow, USSR (27 May 1968).

On the basis of the operating principle and parameters of the paramagnetic crystals of quantum paramagnetic amplifiers, the requirements to be satisfied by the characteristics of superconducting magnets and solenoids are given. The results of development and experimental verification of superconducting magnets and solenoids with winding of copper-plated and insulated grade RNS wire and shields of NT-1 alloy and compound are presented together with their design peculiarities. Types of superconducting magnets and sectionalized solenoids are created in the developmental process. (JPRS)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 20527, 21032, 21776, and 22110.

21612 (TID-25736(Suppl.2)) CINDA 71: AN INDEX TO THE LITERATURE ON MICROSCOPIC NEUTRON DATA. Supplement 2. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut. ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France). International Atomic Energy Agency, Vienna (Austria). Nuclear Data Unit). 1 Dec 1971. 427p. Dep. NTIS. IAEA $24.00.

21613 NEUTRON PROPERTIES OF ORGANIC MODERATORS AND COOLANTS. Sefidvash, F. (Arya-Mehr Univ. of Tech., Tehran). Nucleus (Karachi); 8: No. 3, 83-7(Jul-Sep 1971).

A comparison of the pulsed-neutron technique and the stationary method of measuring diffusion parameters of thermal neutrons is made. The measurements presently made on Santowax-R and Dowtherm-A by these methods are compared with the results of the theoretical neutron scattering model developed by the author. The model was further tested by measuring the cold neutron cross sections of benzene, diphenyl, Dowtherm-A, m-, o-, and p-terphenyl molecules. (auth)

21614 NEUTRON THERMALIZATION IN H_2O AT 318° AND 77°K. Ishmaev, S. N.; Sadikov, I. P.; Chernyshov, A. A. At. Energ. (USSR); 32: No. 1, 33-8(Jan 1972). (In Russian).

Time dependence of the neutron thermalization process in light water (T = 318°K) and ice (T = 77°K) have been studied experimentally by measuring a time-dependent neutron flux for some fixed neutron energies. A crystal spectrometer combined with a pulsed neutron source was used for this purpose. The experimental results for water are in agreement with previously performed numerical calculations based on the Nelkin model for H_2O. It is shown that the first eigenvalue of the Boltzmann equation is discrete for H_2O and the neutron thermalization time constant is determined as 5.8 ± 0.6 μs (water, 318°K) and 55.5 ± 1.5 μs (ice, 77°K). (auth)

21615 TOTAL CROSS SECTIONS OF VARIOUS HOMOGENEOUS SUBSTANCES FOR ULTRACOLD NEUTRONS. Steyerl, Albert; Vonach, Herbert (Technische Univ., Munich). Z. Phys.; 250: No. 2, 166-78(1972).

By transmission measurements at the time-of-flight spectrometer for ultracold neutrons at the FRM Munich, the total cross sections of gold, aluminum, and copper were determined as a function of neutron energy in the range $10^{-7} < E < 5 \times 10^{-4}$ eV and the temperature range 33 to 303°K. No significant deviations from the expected 1/v dependence of the cross sections were found if the neutron velocity v is corrected for the index of refraction. From the measured total cross sections at low temperature the following values for the thermal capture cross sections could be calculated: Au: 99.3 ± 0.5 b; Al: 227 ± 6 mb; and Cu: 3.77 ± 0.12 b. For aluminum in addition a value of 389 ± 50°K for the Debye temperature at 298°K could be obtained from the temperature dependence of the total cross sections. Additional measurements on glass, mica, and air also showed proportionality of the total cross sections to 1/v. (auth)

21616 SPIN-ORBIT EFFECTS IN THE INDEX-OF-REFRACTION FORMALISM FOR POLARIZED NEUTRONS. Handel, Peter H. (Univ. of Missouri, St. Louis). Phys. Rev. Lett.; 28: No. 10, 596-9(6 Mar 1972).

Previously unexplained asymmetries observed in neutron guides are described by modifying the neutron index-of-refraction formalism through the inclusion of the spin–orbit interaction. The latter is due to the magnetic moment of the neutron in the electrostatic dipole field at the surface of the neutron mirror. For a single reflection, this effect may be of about 1% per volt of surface dipole, and it provides a direct method of measuring the surface dipole barrier. (auth)

21617 INCOHERENT NEUTRON SCATTERING BY SIMPLE CLASSICAL LIQUIDS FOR LARGE MOMENTUM TRANSFER. Sears, V. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., A; 5: No. 1, 452-62(Jan 1972).

The general form for the moments of the Van Hove incoherent scattering function is derived for a simple classical liquid with velocity-independent interatomic forces. With the additional assumption of additive central forces, explicit expressions are obtained for the coefficients which determine the asymptotic behavior of the moments at large momentum transfer κ. This enables one to obtain an exact asymptotic expansion of the scattering function in inverse powers of κ. The theory is applied in detail to the Lennard–Jones liquid at the triple point and to the hard-sphere fluid at arbitrary density. The results for these two cases are qualitatively different as a consequence of the fact that the atomic velocities are continuous functions of time in the former case and discontinuous in the latter. For example, the leading correction to the impulse approximation due to final-state interactions is proportional to κ^{-2} for the Lennard–Jones potential and to κ^{-1} for hard spheres. With decreasing κ the scattering function changes from the Gaussian shape, characteristic of the impulse approximation at large κ, to the Lorentzian shape characteristic of simple diffusion at small κ. This change occurs in the hard-sphere fluid when $\kappa l \sim 1$, where l is the mean free path (including the Enskog factor). (auth)

21618 EIGENVALUE SPECTRUM OF THE NEUTRON-TRANSPORT OPERATOR FOR A FAST MULTIPLYING SYSTEM. Ukai, Seiji; Hiraoka, Toru (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 36-46(Jan 1972).

The eigenvalue spectrum of the neutron transport operator for fast multiplying systems is discussed under the continuous energy treatment and with the assumption of isotropic distribution of the neutrons emitted by scattering and fission. In particular, the sufficient conditions are presented for the existence and non-eixstence of what is known as the fundamental mode. Further, it will be shown that, if the energy transfer kernel is positive almost everywhere, then the eigenvalue for the fundamental mode is strictly larger than the real part of any other eigenvalue and there are no non-negative eigenfunctions excepting the fundamental mode. (auth)

21619 FAST NEUTRON SPECTRA FROM SPACE DEPENDENT CONTINUOUS SLOWING DOWN THEORY. Burns, Edward Thomas. Troy, N. Y.; Rensselaer Polytechnic Inst. (1971). 360p. University Microfilms Order No. 72-1180.

Thesis.

A clear, well understood, and flexible procedure for analyzing space dependent slowing down is shown to provide a useful analytical tool over the energy range of interest in fast reactors. The method used to generate the slowing down spectrum is based on the form of the "standard" slowing down equations, with parameters ξ (u) and γ (u) redefined to include inelastic scattering. A comprehensive testing of this approach has been carried out for the space independent problem, and for slowing down in single materials. The extension to spatial dependence was made using the Age formalism. A significant practical application of this simple yet physically meaningful approach, is the establishment of a technique for relating observed spectral differences between calculation and experiment to basic cross section uncertainties. Such a tool is a useful asset for the analysis of integral spectrum experiments similar to those carried out at Rensselaer on neutron slowing down in bulk media. Such an experiment, with adequate analysis, offers the potential of testing both the cross section data files for a given material and the analytic tools used to process and calculate space dependent slowing down spectra. In establishing the credibility of the Age formalism to describe the neutron slowing down process (including inelastic scattering), spectral comparisons in four elements (Na, Al, Fe, and ^{238}U) are performed. Uncertainties in the iron and ^{238}U cross section files are pinpointed through the combined use of the integral experiment and the simple theory. The applicability of several integral parameters are discussed with respect to the fast spectrum experiment. A discussion is also included on the effects of various weighting functions, including space dependent weightings, on broad group cross sections and the resulting spectral calculations. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 21368, 21490, 21739, and 21890.

21620 ENERGY SPECTRA OF BREAKUP PROTONS FROM THE D(n,p)2n REACTION BY 14.1 MeV NEUTRONS. Koori, Norihiko (St. Paul's Univ., Tokyo). J. Phys. Soc. Jap.; 32: No. 2, 306-15(Feb 1972).

The energy spectra of breakup protons with energy larger than

1.2 MeV from the D(n,p)2n reaction by 14.1 MeV neutrons have been measured, in terms of the absolute cross section ($d^3\sigma/d\Omega E_p$), at 9 proton emission angles between 4° and 60° with a counter telescope. The measured breakup proton spectra agree fairly well with those measured by the Zagreb group at 4.8° and 10°, but are about 30% larger than their spectra at angles larger than 20°. The present spectra are in excellent agreement with the recent calculation of Cahill and Sloan at angles up to 60°, except for the discrepancy of 25% in the n-p final-state-interaction region of the spectrum for angles less than 20°. The differential cross section ($d\sigma/d\Omega$) for the breakup reaction has been also obtained and discussed. (auth)

21621 CALCULATION OF MESON-EXCHANGE CORRECTIONS TO TRITON BETA DECAY USING REALISTIC NUCLEAR WAVE FUNCTIONS. Fischbach, E. (Purdue Univ., Lafayette, Ind.); Harper, E. P.; Kim, Y. E.; Tubis, A.; Cheng, W. K. Contract AT 4997-54-13965. Phys. Lett.; 38B: No. 1, 8-12(10 Jan 1972).

The one-pion-exchange contribution to the axial-vector matrix element for $^3H + {}^3He + e^- + \bar{\nu}_e$ is calculated. The model of Cheng, based on CVC and PCAC, is used to determine the corrections to the axial-vector operator, and trinucleon wave functions are calculated by solving the Faddeev equations for the Reid soft-core nucleon-nucleon potential. The S–D transition matrix elements give the dominant contributions in agreement with previous results of Blomqvist and of Riska and Brown. (auth)

21622 STUDY OF THE NEUTRON–PROTON CORRELATION IN THE DISINTEGRATION OF THE DEUTERON. Tomas, P.; Furic, M.; Valkovic, V.; Miljanic, D.; Antolkovic, B. (Inst. Ruder Boskovic, Zagreb). pp 335-8 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Neutron-proton angular correlations were measured in the D(n,np) reaction at 14.4 MeV in order to identify the reaction mechanisms. A counter telescope and a neutron detector in combination with a three-parameter analyzing system were used along with the associated-alpha-particle technique to record and analyze the data. Equal magnitudes for the quasifree scattering mechanism and the final-state interaction mechanism were found. (J.W.R.)

21623 CHARGE SYMMETRY AND THE $^2H(\vec{d},n)^3He$ REACTION. Blyth, C. O.; Dunscombe, P. B.; McKee, J. S. C.; Pope, C. (Univ. of Birmingham, Eng.). Nucl. Phys.; A181: No. 1, 189-95(1972).

An angular distribution of the vector analyzing power of the reaction $^2H(\vec{d},n)^3He$ is presented, for an incident deuteron energy of 11.4 MeV. In a comparison of these data with those of Berovic and Clews for the $^2H(\vec{d},p)^3H$ reaction at the same energy, no departure from charge symmetry is observed. (auth)

21624 INVESTIGATION OF T equals O EXCITED STATES OF ^4He VIA THE $^4He(d,d't)^1H$ AND $^4He(d,d'\vec{t})^2H$ REACTIONS. Lin, E. K.; Hagelberg, R.; Haase, E. L. (KeUniv., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A179: No. 1, 65-79(1972).

The three-particle reactions $^4He(d,d't)^1H$ and $^4He(d,d'\vec{d})^2H$ were investigated at an incident energy of 52 MeV. The energy spectra of tritons and deuterons were measured simultaneously with inelastically scattered deuterons with two detectors, one at a fixed angle of 31° lab and the other at varied angles ranging from 20° to 38° lab. The data are interpreted in terms of six resonances arising in final-state interaction through T = 0 excited states of ^4He. Only the lower three resonances are prominent in the data. The extracted resonance parameters (energies and widths) are consistent with those obtained from measurements of similar reactions in two other different entrance channels. A summary of results from the present measurement and the two others is presented and compared with results from the phase-shift analysis. Singles spectra from the $^4He(d,d')^4He^*$ reaction were also obtained and used in addition to the coincidence data in the analysis. The validity of the sequential reaction mechanism is examined. (auth)

21625 OBSERVABLES OF THE NEUTRONS ELASTICALLY SCATTERED BY DEUTERONS AT LOW ENERGY. Jaccard, S.; Viennet, R. (Univ., Neuchatel, Switzerland). Nucl. Phys.; A182: No. 3, 541-8(1972).

Up to now every published analysis of elastic n-d scattering at low energy has been made in the framework of the diagonal J-degenerate model. It is shown that in this case only two neutron observables are independent, namely the differential cross section and the depolarization factor. The results of a calculation of the depolarization factor D for the existing sets of phase shifts are presented. Suggestions for future work are given. (auth)

21626 MICROSCOPIC DESCRIPTION OF ELASTIC $p-{}^3He$ SCATTERING. Heiss, P.; Hackenbroich, H. H. (Univ., Cologne). Nucl. Phys.; A182: No. 3, 522-8(1972).

Starting from a nucleon–nucleon potential containing soft-core central, spin-orbit, and tensor forces, the $p-{}^3He$ scattering states were calculated. All possible couplings of $p-{}^3He$ channels were considered. Cross sections and polarization values resulting from these calculations are compared with experiment and agree well. (auth)

21627 COMPARISON OF THE VECTOR ANALYSING POWERS OF THE MIRROR REACTIONS $^2H(\vec{d},p)^3H$ AND $^2H(\vec{d},n)^3He$. Hilscher, D.; Liers, H. S. (Univ. of Wisconsin, Madison). Nucl. Phys.; A179: No. 1, 187-92(1972).

The vector analyzing powers iT_{11} of the reactions $^2H(\vec{d},p)^3H$ and $^2H(\vec{d},n)^3He$ have been measured simultaneously at a deuteron energy of 10 MeV for cm angles between 118 and 146° by detecting the tritons and helions at lab angles between 26.2 and 14.9°. Apart from the uncertainty in the absolute value of the beam polarization the experimental uncertainty in iT_{11} for both reactions was less than ±0.002. For angles larger than 134° in the cm system the vector analyzing power iT_{11} of the reaction $^2H(\vec{d},p)^3H$ is larger than the vector analyzing power of the reaction $^2H(\vec{d},n)^3He$, and the difference increases with increasing angle. (auth)

21628 COINCIDENCE SPECTRA FROM d + d → d + p + n AND p + d → p + p + n REACTIONS WITH NEUTRON DETECTION AT ZERO DEGREES. Vaikovic, V.; Gabitzsch, N.; Rendic, D.; Duck, I.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Phys.; A182: No. 2, 225-33(1972).

Proton–neutron coincidence spectra from the p + d → p + p + n reaction were measured for $\theta_n = 0°$ and $\theta_p = 15°$ to 40° at $E_p = 10.0$ MeV. Deuteron–neutron coincidence spectra from the d + d → d + n + p reaction were measured for $\theta_n = 0°$ and $\theta_d = 15°$ to 35° at $E_d = 10.0$ MeV. Coincidence spectra were analyzed in terms of a quasi-free scattering model. The possibility of using these reactions as a source of monoenergetic neutrons is discussed. (auth)

21629 VECTOR AND TENSOR POLARIZATIONS IN NUCLEON-DEUTERON SCATTERING. Aarons, J. C. (Univ. of New South Wales, Kensington, Australia); Sloan, I. H. Nucl. Phys.; A182: No. 2, 369-84(1972).

The results of exact calculations of neutron–deuteron scattering with a noncentral, spin-dependent, separable, two-body force are presented. The two-body force has just two separable terms, corresponding to the bound deuteron and the antibound singlet deuteron. The model is, therefore, that obtained by the pole-dominance argument of Lovelace or the equivalent one-nucleon-exchange approach of Amado; and the only noncentral part of the two-body force is that needed to produce a bound deuteron with the correct ($^3S_1 + {}^3D_1$) structure. The calculations, over a range of 3 to 23 MeV for the neutron laboratory energy, yield vector polarizations that are very small compared with experiment and of the wrong shape. On the other hand, the second-rank tensor polarization moments of the deuteron are in qualitative agreement with experiment. Thus, the model is not adequate for explaining vector polarizations but apparently is at least qualitatively adequate for second-rank polarization moments, as well as (as is already known) for differential cross sections. This is plausibly connected with the fact, discussed herein, that the simple one-nucleon-exchange process (without iterations) produces second-rank tensor polarizations (and differential cross sections) of substantial magnitude, whereas it produces no vector polarization at all. (45 references) (7 figures) (auth)

21630 BINDING ENERGY OF TRITON AND SCATTERING LENGTHS IN NEUTRON–DEUTERON COLLISION IN FADDEEV FORMALISM WITH LOCAL POTENTIAL. Purkayastha, Gita; Banerjee, S. N.; Sil, N. C. (Indian Association for the Cultivation of Science, Calcutta). Nucl. Phys.; A182: No. 2, 443-8(1972).

A separable representation for the off-shell two-body t matrix for a local Hulthén potential is presented, in which deuteron states are chosen as the expansion bases. With the Faddeev equations with these t matrices as input, the ground-state energy of the triton and doublet and quartet scattering lengths in neutron–deuteron scattering are computed. The results are compared with the experimental findings and the theoretical results of Sitenko et. al., obtained in the Sturmian function representation with the same Hulthén potential. (1 table) (auth)

21631 EXCITED STATES IN THE THREE-BODY SYSTEM. Alt, E. O. (Univ., Mainz); Sandhas, W.; Grassberger, P. Nuovo Cim.; 8A: No. 1, 211-14(1 Mar 1972).

Three-body excited states are calculated in a local potential model by means of the quasi-particle method. The improvement over the approach in which the local potential is approximated by a separable one is demonstrated. (1 figure) (auth)

21632 MICRODYNAMIC STUDIES IN SOME HYDROGENOUS SUBSTANCES BY COLD NEUTRON TRANSMISSION. Rapeanu, S.; Padureanu, I.; Iliescu, N.; Dumitru, O. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 8, 865-9(1971). (In Rumanian).

The total cross section as a function of cold neutron energy for methyl, ethyl, and ethylene glycol alcohols was studied using a neutron crystal spectrometer in the energy range E = 6.7 to 1.27 MeV. The changes of the slopes ($\Delta\sigma_s/\Delta\lambda_n$) illustrate the role of the hydrogen bond (OH-group) of the CH_3 and CH_2 groups on the rotational motions of the molecules. Transmission measurements were carried out at the temperatures 298, 123, and 78°K. (3 figures, 1 table) (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 20430, 21080, 21108, 21485, 21490, 21668, 21669, 21687, 21739, 21838, and 22153.

21633 (COO-535-649) EXCITATION ENERGIES OF LEVELS IN ^{16}F, ^{20}Na, AND ^{24}Al. Moss, C. E.; Comiter, A. B. (Colorado Univ., Boulder. Nuclear Physics Lab.). [1971]. 20p. Dep. NTIS.

Neutron time-of-flight spectra from the reactions $^{16}O(p,n)^{16}F$, $^{20}Ne(p,n)^{20}Na$, and $^{24}Mg(p,n)^{24}Al$ at E_p = 23 MeV were used to locate levels in ^{16}F, ^{20}Na, and ^{24}Al. The excitation energies are compared with previously reported values and with the predictions from Coulomb displacement calculations. (auth)

21634 (FRNC-TH-147) STUDY OF ΔT = 1 TRANSITIONS: THE $^{14}N(n,p)^{14}C$ REACTION AT 14 MeV. Coudurier, Jacques (Grenoble Univ. (France)). 1971. 44p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The differential cross section of the $^{14}N(n,p)^{14}C$ reaction was measured at 14 MeV using a gas target. The result obtained is compared with the differential cross sections of the $^{14}N(p,p')^{14}N^*$, $^{14}N(n,n')^{14}N^*$, and $^{14}N(p,n)^{14}O$ reactions which result in analog ^{14}C states. The data were analyzed using the DWBA and a microscopic model for the nucleus. The nucleon–nucleon potential used enabled spin and isospin exchange interactions to be introduced. (France)

21635 (HASL-247) NUCLEAR EMULSION MEASUREMENTS OF THE SECONDARY NEUTRON SPECTRUM PER STERADIAN FROM THE SPALLATION OF CARBON. Sanna, Robert S.; O'Brien, Keran (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Dec 1971. 12p. Dep. NTIS.

The secondary neutron spectrum from carbon bombarded by 1- and 3-GeV proton beams was measured with nuclear emulsions. Such data from thin, low atomic number targets are useful as a check on the intranuclear cascade models from which the basic data for high-energy hadron transport calculations are drawn. Emulsions were exposed in an arc about targets located in the 1-GeV Cosmotron proton beam and the 3-GeV Princeton-Pennsylvania proton beam. The emulsion proton distributions between about 0.5 and 40 MeV were measured at several angles and neutron spectra were inferred. Corrections were made for recoil proton escape from the emulsion and for the probability of protons having non-elastic collisions before stopping. Escape correction factors were estimated by means of a Monte Carlo technique developed at HASL using the neutron spectrum from the bombardment of an aluminum target by 2-GeV protons, reported by Alsmiller and his co-workers at Oak Ridge National Laboratory as a model. Results are presented for a few angles and the experimental methods are discussed. (auth)

21636 (IAE-2031) REACTIONS $^9Be(^6Li,d)^{13}C$ AND $^9Be(^7Li,t)^{13}C$. Goldberg, V. Z.; Davydov, V. V.; Ogloblin, A. A.; Sakuta, S. B.; Chuev, V. I. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The reactions $(^6Li,d)$ and $(^7Li,t)$ on Be nuclei at energies E(6) = 23.8 MeV and E(7) = 30.3 MeV were studied, and it was shown that in these reactions the nuclear targets were transmuted by direct processes of α particles. Some levels have α-particle natures. (tr-auth)

21637 (IS-T-467) SOLUBLE MODEL CALCULATIONS OF THE CONTINUUM STRUCTURE OF CLOSED-SHELL NUCLEI IN THE EIGENCHANNEL REACTION THEORY. Gieraltowski, Gerald Francis (Ames Lab., Iowa). Nov 1971. Contract W-7405-eng-82. 170p. Dep. NTIS.

Thesis.

An analysis of the eigenchannel formalism as applied to the reaction theory of photonuclear absorption processes is discussed and analyzed within the one-particle-one-hole framework. An application is made of the eigenchannel theory to the photonuclear absorption processes for ^{12}C in the energy range 16 MeV ≤ E_γ ≤ 40 MeV with a single-particle potential of the square well type plus $\vec{L}\cdot\vec{S}$ and $\vec{L}^2$ terms. The basic residual interaction between the particle and hole states is taken to be of the surface-delta form. Analytic expressions for both the neutron and proton wave functions are derived and the entire eigenchannel calculation is performed as exactly as possible with an absolute error in the photoabsorption cross section values of less than six percent. It was observed that spurious peaks occur in the cross section if the nonorthogonality of the single-particle basis states is not properly taken account of. A method for eliminating these spurious components is derived and an analysis of the resultant ^{12}C photoabsorption cross sections shows relatively good agreement between the resonance peaks found by the eigenchannel analysis and those from experiment. The experimental interpretation of resonance structure above the giant resonance as being attributable to single-particle excitations from low-lying closed shells is supported by the eigenchannel analysis of the ^{12}C photoabsorption reaction. The fact that the eigenchannel theory can and does produce nuclear reaction information in good accord with experiment tends to support its continued use. However, because of the excessive computer time involved in such a calculation and the preponderance of numerical difficulties associated with it, extensive applications of the eigenchannel theory as presently formulated must be questioned. (auth)

21638 (LA-DC-13270) EVALUATION OF THE NEUTRON AND GAMMA-RAY PRODUCTION CROSS SECTIONS FOR NITROGEN. Young, P. G.; Foster, D. G. Jr. (Los Alamos Scientific Lab., N. Mex.). [1971]. 45p. (CONF-711125-6). Dep. NTIS.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

A complete, internally-consistent evaluation of the neutron and gamma-ray production cross sections of nitrogen was completed and is available in ENDF/B (III) format. In addition to incorporating all available direct experimental information, extensive use was made of branching ratios obtained in charged-particle reactions, of data on inverse and charge-symmetric reactions, and on Hauser–Feshbach and evaporation calculations. In the vicinity of the famous nitrogen discrepancy near 8 MeV, the elastic cross section is substantially higher than the 1967 Livermore measurements (Ba67) but is in good agreement with the recent work of Perey and Kinney (Pe71) and Nellis (Ne70). (auth)

21639 (LA-DC-13271) PRELIMINARY EVALUATION OF THE NEUTRON AND PHOTON-PRODUCTION CROSS SECTIONS OF OXYGEN. Foster, D. G. Jr.; Young, P. G. (Los Alamos Scientific Lab., N. Mex.). [1971]. 36p. (CONF-711125-2). Dep. NTIS.

From Radiation Shielding Information Center seminar-workshop; Oak Ridge, Tenn. (15 Nov 1971).

A preliminary reevaluation of the neutron cross sections of ^{16}O was completed. The revised total cross section is based almost entirely on recent time-of-flight measurements, which are in good mutual agreement. The "window" at 2.35 MeV is shallower and comes at a lower energy than in the 1965 KAPL evaluation, and the cross section near 14 MeV is now about 15% higher. Angular distributions for elastic scattering were taken from the KAPL evaluation below 6 MeV, from recent measurements up to 14 MeV, and from optical-model calculations constrained to agree with the measured total cross section above 14 MeV. The integrated elastic cross section is now about 50% higher above 10 MeV. The inelastic cross section was reduced about a factor of two between 7 and 12 MeV on the basis of photon-production measurements, then rises sharply, crossing the KAPL evaluation at 14 MeV. Part of the rapid rise above 12 MeV results from transferring the $(n,n'\alpha)$ and $(n,\alpha n')$ cross sections from the (n,α) to the (n,n') file, using the newly-established ENDF/B flag to indicate charged-particle emission. The photon-production cross sections are taken from the available measurements, supplemented by compound-nucleus reaction-theory calculations where necessary. The complete evaluation is available in ENDF/B-III format. (auth)

21640 (ORNL-tr-2563) INTRANUCLEAR CASCADES IN LIGHT NUCLEI. Abdinov, O. B.; Barashenkov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR-P2-5991. 8p. Dep. NTIS.

The effect of a decrease in intranuclear nucleon number density as a result of the nucleons being knocked out by a growing avalanche of fast cascade particles in the mechanism of intranuclear cascades is studied for proton inelastic scattering by carbon-12. (J.F.P.)

21641 SPALLATION REACTIONS PRODUCED BY 50, 100, AND 153 MeV PROTONS WITH LIGHT NUCLEI. Bimbot, Rene; Gauvin, Henri (Univ. Paris, Orsay, France). Compt. Rend., Ser. B; 273: No. 23, 1054-7(8 Dec 1971). (In French).

N, O, ^{18}O, F, Mg, Al, Si, and Cl targets were irradiated with 50-, 100-, and 153-MeV protons. The cross sections for residual nuclei production (^{7}Be, ^{11}C, ^{13}N, ^{18}F, ^{22}Na, ^{24}Na and ^{34m}Cl) were determined. (France)

21642 THEORY OF LOW-ENERGY (p,2p) REACTIONS IN THE 1p SHELL. Janiszewski, J.; McCarthy, I. E. (Flinders Univ. of South Australia, Bedford Park). Nucl. Phys.; A181: No. 1, 97-100(1972).

(p,2p) experiments with incident energies near 50 MeV are now available for the 1p shell protons in three different nuclei ^{12}C, ^{16}O and ^{14}N. The Q-values are respectively 16 MeV, 12 MeV and 8 MeV. The distorted wave approximation using a local model for the pp t-matrix is applied to all three and a pattern is observed in the discrepancies between theory and experiment. The discrepancy increases as the Q-value increases. It is suggested, with support from plane-wave calculations using the actual t-matrix of a realistic pp potential, that the theory will be greatly improved by including the best-possible t-matrix in the distorted wave theory. (auth)

21643 CALCULATION OF THE ^{12}C + α CAPTURE CROSS SECTION AT STELLAR ENERGIES. Barker, F. C. (Australian National Univ., Canberra). Aust. J. Phys.; 24: No. 6, 777-92 (Dec 1971).

The ^{12}C$(\alpha,\gamma)^{16}$O cross section is calculated at stellar energies, using R-matrix parameters obtained by fitting consistently the ^{12}C + α scattering phase shifts and the α-spectrum from ^{16}N β-decay. This limits the ^{12}C + α channel radius to the range 5-7 fm. The S-factor at E_{cm} = 400 keV is calculated to lie in the range 0.05-0.33 MeV.b. (auth) (Australia)

21644 NEGATIVE PION CAPTURE ON ^{12}C WITH EMISSION OF NEUTRON-PROTON PAIRS. Lee, D. M.; Minehart, R. C.; Sobottka, S. E.; Ziock, K. O. H. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A182: No. 1, 20-32(1972).

Energy and angle measurements of neutron-proton pairs emitted after π^- capture in ^{12}C have been made. The data are in partial agreement with several theories. Some evidence indicates that limits on the short-range correlation parameters might be determined from the nn/np ratio at backward angles. (auth)

21645 INELASTIC SCATTERING OF 17-MeV PROTONS FROM ^{14}N AND ^{15}N. Rogers, Charles William. Corvallis, Oregon State Univ. (1971). 82p. University Microfilms Order No. 72-5099.

Thesis.

An inelastic scattering experiment was done in which 17-MeV protons were scattered from ^{14}N and ^{15}N gas targets. Angular distributions are shown for the ground, 6.32-, 7.56-, 8.31-, and 8.57-MeV states and the 5.3- and 7.2-MeV unresolved doublets of ^{15}N, and for the ground, 2.3-, 3.9-, 6.2-, 6.4-, and 7.0-MeV states and the 5-, 5.7-, 8-, and 8.5-MeV unresolved doublets of ^{14}N. Reasonable fits to the data were obtained for the 6.32-MeV ^{15}N state and the 2.3- and 3.9-MeV ^{14}N states using a microscopic potential in a coupled-channel calculation. The use of a tensor force improved the fits to both the 6.32-MeV ^{15}N state and the 2.3-MeV ^{14}N state. A weak-coupling model was considered in which excited ^{15}N states are formed by coupling a $p_{\frac{1}{2}}$ proton hole to excited states of ^{16}O. The model adequately represents the 5.27- and 7.56-MeV ^{15}N states as being formed from the 6.13-MeV ^{16}O state, and the 5.30- and 7.30-MeV ^{15}N states as being formed from the 7.12-MeV ^{16}O state. The 6.32-MeV ^{15}N state does not seem to be related to the 6.92-MeV ^{16}O state, but evidence was presented that the 9.16-MeV ^{15}N state is related by the weak-coupling model to the 6.92-MeV ^{16}O state. (Diss. Abstr. Int., B)

21646 TREIMAN-YANG TEST FOR THE POLE APPROXIMATION IN ^{6}Li(p,pd)^{4}He AT 19 MeV. Liebert, Reuel Baruch. Rochester, N. Y.; Univ. of Rochester (1971). 233p. University Microfilms Order No. 72-740.

Thesis.

The reaction mechanism of ^{6}Li(p,pd)^{4}He was tested with the Treiman-Yang criterion and information about the cluster structure of ^{6}Li was obtained. The data was taken with a 19.0 MeV proton beam produced by the Model MP Tandem Van de Graaff accelerator at the University of Rochester. In a peripheral model (or "pole approximation"), the reaction can be described as an incident proton scattering from a deuteron which originates in the virtual decay of ^{6}Li into its component clusters. When viewed in the coordinate system of the incident proton (the "anti-laboratory"), the reaction looks like an incident deuteron beam impinging on a proton target. The amplitude should be isotropic with respect to rotations of the proton-deuteron plane about the deuteron "beam" axis in this coordinate system when the deuteron originates from a relative S-state in ^{6}Li. The Treiman-Yang test requires the measurement of the distribution with respect to the angle between the p-d and α-^{6}Li planes (The Treiman-Yang angle) in the anti-laboratory system. The Treiman-Yang distributions were obtained by measuring the outgoing proton and deuteron energies with surface barrier detectors. The deuterons were identified in a counter telescope and the time of flight difference of the particles was measured in order to reduce background. The energies and time difference were stored on magnetic tape for each coincident event and the data analyzed off-line with a PDP-6 computer. The resulting T-Y distributions were consistent with the isotropic pole prediction in the 0-60 MeV/c region. Absolute cross-sections were measured at six angles bracketing the p-d elastic scattering angle combination. The data was fitted with the Shapiro pole theory and the quasi-elastic scattering approximation. A channel radius of 5.7 fm taken from (p, ^{3}He) work was used with a Butler form factor to construct an effective cluster wave function, and the momentum wave function had to be shifted 15 MeV/c in order to fit the data. The normalization of the fitted curves in the region satisfying the T-Y test was used to obtain a value for the reduced width of the deuteron in an l = 0 state in ^{6}Li, $\theta^2 = 0.23 \pm 0.09$, and an effective number of deuteron clusters in ^{6}Li, $N_{eff} = 0.13 \pm 0.05$. (Diss. Abstr. Int., B)

21647 (α, τ) AND (α, t) REACTIONS WITH 104 MeV α-PARTICLES. Hauser, G. (Univ., Heidelberg); Loehken, R.; Nowicki, G.; (and others). Nucl. Phys.; A182: No. 1, 1-19(1972).

The differential cross sections for the one-nucleon stripping reactions and the elastic scattering of 104 MeV α-particles on ^{12}C, ^{27}Al and ^{40}Ca were measured. The experimental results show that the (α, ^{3}He) cross sections are larger than those obtained from (α, t) reactions on the same target nuclei. The reaction data were analyzed in the framework of the DWBA. The calculations using the zero-range approximation are able to reproduce the measured angular distributions. In addition the effect of finite-range corrections were studied in the local energy approximation. From the analysis it becomes evident, that the inner part of the target nucleus contributes significantly to the reaction cross section. The larger yield of ^{3}He particles compared to that of tritons can be explained mainly by different normalization factors for the (α, ^{3}He) and (α, t) reactions, respectively. (auth)

21648 REACTION-PLANE AND SPIN-FLIP ANGULAR CORRELATIONS IN THE REACTIONS ^{12}C$(\tau,\tau_1\gamma_{4.43})^{12}$C AND ^{12}C$(\alpha,\alpha_1\gamma_{4.43})^{12}$C. Assousa, G. E.; Ahlfeld, C. E.; Lasalle, R. A.; (and others) (Florida State Univ., Tallahassee). Nucl. Phys.; A182: No. 1, 193-212(1972).

Reaction-plane particle-γ angular correlations were measured in the reaction ^{12}C$(^{3}$He,^{3}He$_1\gamma)^{12}$C at 17 MeV as a function of the γ-ray angle for forty-three ^{3}He (lab) scattering angles from 13.5° to 170°. The ^{3}He$_1$-γ angular correlation function with the γ-ray detector at 90° to the reaction plane was measured for twenty ^{3}He (lab) angles from 19° to 114° and the spin-flip probability P_1 was extracted. For comparison of τ and α interactions, reaction-plane correlations were obtained for the ^{12}C$(\alpha,\alpha_1\gamma)^{12}$C reaction at 19 MeV for fifty-five α (lab) scattering angles from 9° to 171°. A coupled-channels analysis of the ^{3}He data assuming quadrupole-deformed collective states in ^{12}C with deformation $\beta_2 = -0.60$ was made. Spin-orbit depth $V_{s.o.}$ and β_2 are shown to be strongly correlated in determining P_1, indicating the inadequacy of DWBA calculations. (auth)

21649 ANALYSIS OF THE ELASTIC SCATTERING OF ALPHA PARTICLES. Makowska-Rzeszutko, M.; Dudek, A.; Drzymala, A. (Inst. of Nuclear Physics, Krakow. Coll. of Engineering, Rzeszow, Poland). Acta Phys. Pol.; B2: No. 6, 771-87(Nov-Dec 1971).

An analysis was carried out of the elastic scattering of 25-MeV alpha particles measured for 24 elements. Experimental angular distributions were reproduced by the Frahn-Venter models, Springer-Harvey models, and the optical model. The models were compared, and the angular range applicable for each model and the reproducibility of the σ_R values were examined. For the Springer-Harvey models ambiguity was found, and sets of parameters without physical significance were noted. The geometrical parameters of nuclei were calculated, and the energy dependence of parameters was observed. (auth)

21650 QUASI-α-PARTICLE PHOTODISINTEGRATION OF ^{6}Li. Kurdyumov, I. V.; Neudatchin, V. G. (Moscow State Univ.). Nucl. Phys.; A182: No. 3, 634-40(1972).

The photodisintegration of the α-cluster in the ^{6}Li nucleus has been studied taking the direct process ^{6}Li(γ,p)td at energies E_γ = 38 to 80 MeV as an example. The spectra and angular distributions of protons, the p–t angular correlation and the dependence of the cross section on the momenta of the d–t relative motion in ^{6}Li have been calculated. The d–t interaction is described by an oscillating separable potential. To clarify the role of forbidden states, we consider also the potential of the d–t interaction in the form of a rectangular well with a forbidden 0s state. The proton spectra in the form of spikes are localized in the vicinity of energies representative of protons of a free α-particle. Taking account of the interaction in the d + t channel most substantially affects the angular distributions and spectra of protons at the lowest energies considered E_γ = 35 to 40 MeV. (auth)

21651 NEW MEASUREMENT OF THE BRANCHING RATIO FOR ^{10}C SUPERALLOWED FERMI DECAY AND ITS SIGNIFICANCE FOR THE WEAK VECTOR INTERACTION. Robinson, D. C. (Atomic Energy Research Establishment, Harwell, Eng.); Freeman, J. M.; Thwaites, T. T. Nucl. Phys.; A181: No. 2, 645-59(1972).

The branching ratio for the pure Fermi decay $^{10}C(\beta^+)^{10}B^{**}$ to the second excited state of ^{10}B was measured by an accurate determination of the ratio of the intensities of 1.022- and 0.718-MeV γ rays following this decay and the Gamow–Teller transition to the first excited state of ^{10}B. Computer programs were devised for accurate analysis of the intensities of the full-energy peaks obtained with a Ge(Li) detector and for deducing the detector relative efficiency from calibration source data. The results were averaged with those from previous measurements of comparable accuracy to give β_1 = (98.53 ± 0.02)% and β_2 = (1.465 ± 0.014)% as the best values of the branching ratios for positron decay to the first and second excited states of ^{10}B, respectively. The ft value of the Fermi transition was deduced as 3155 ± 40 s with radiative corrections; and the corresponding vector coupling constant, as $G_\beta^V = (1.396 \pm 0.009) \times 10^{-49}$ erg · cm^3. (8 figures, 5 tables) (auth)

21652 WEAK COUPLING CALCULATION FOR THE A = 14 NUCLEI. Lie, S. (Univ. of Oslo). Nucl. Phys.; A181: No. 2, 517-44(1972).

A calculation of the A = 14 levels is performed by using the weak coupling approach. Very good agreement with experiment is obtained as all known levels below 13 MeV in ^{14}N are satisfactorily explained. A few additional states are predicted to be found. The electromagnetic transition strengths are calculated and reproduce the experimental values in almost all cases; in particular, a simple calculation of the isospin mixture of the negative-parity states provides an explanation of the known T-forbidden E1 transitions. Also, the reduced proton widths are considered and are found to be consistent with (p,p) scattering experiments on ^{13}C. (4 figures, 12 tables, 48 references) (auth)

21653 STUDY OF THE ^{9}Be(p,pα)^{5}He REACTION AT 26.0, 35.0, AND 46.8 MeV. Quinn, J. R.; Epstein, M. B.; Bunker, S. N.; Verba, J. W.; Richardson, J. Reginald (Univ. of California, Los Angeles). Nucl. Phys.; A181: No. 2, 440-52(1972).

The cross sections for the reaction ^{9}Be(p,pα)^{5}He were measured at 26.0, 35.0, and 46.8 MeV incident energies. The resulting data were analyzed in the plane-wave impulse approximation and compared to the results of existing data taken at 55.0, 57.0, 155.0, and 160 MeV. These data appear to be consistent with an s state of relative motion of the α cluster. (10 figures) (auth)

21654 WEAK COUPLING MODEL APPLIED TO THE NUCLEI WITH A = 16 TO 19. II. GAMMA TRANSITIONS AND SPECTROSCOPIC FACTORS. Engeland, T. (Univ. of Oslo); Ellis, P. J. Nucl. Phys.; A181: No. 2, 368-402(1972).

Particle–hole states were formulated according to the weak-coupling model where the particle and hole wave functions are, respectively, eigenfunctions of the particle–particle and hole–hole parts of the Hamiltonian. Previously, the energy levels have been found to be given well by this model; here, an extensive comparison between theoretical predictions and experimental data on γ transitions and spectroscopic factors for the nuclei with A = 16 to 19 is made. Some discrepancies are found, particularly for the 3p–3h states in ^{16}O, but on the whole the agreement is good and confirms the validity of the weak-coupling model. (3 figures, 16 tables, 73 references) (auth)

21655 4p-2h INTERMEDIATE STATES AND THE EFFECTIVE INTERACTION IN MASS-18 NUCLEI. Rajewski, Jerzy (Weizmann Inst. of Science, Rehovot, Israel. Nuclear Research Centre-Negeev, Beer Sheva, Israel); Kirson, Michael W. Nucl. Phys.; A181: No. 2, 409-16(1972).

A set of diagrams with 4p–2h intermediate states is summed. The result is more attractive than that obtained in lowest order, the effect being mainly on J = 0, T = 1 and T = 0 states. The ground states are depressed; this result improves somewhat the fit to experiment. (4 figures, 2 tables) (auth)

21656 ALPHA CLUSTERING IN LIGHT NUCLEI WITH DENSITY DEPENDENT FORCES. Friedrich, H.; Huesken, H.; Weiguny, A. (Univ., Muenster, Ger.). Phys. Lett.; 38B: No. 4, 199-202(21 Feb 1972).

Equilibrium α-cluster configurations are calculated for light 4N nuclei by using a Skyrme interaction. It is shown that the use of parity- or angular momentum-projected trial wave functions considerably enhances the formation of α clusters. Altogether, slightly less α clustering is obtained than in comparable calculations using the simple effective interaction B1 of Brink and Boeker. (auth)

21657 PARITY NONCONSERVING ALPHA-DECAY FROM THE 3^+, T = 0 11.06 MeV STATE IN ^{16}O. Fink, M. (Ruhr Univ., Bochum, Ger.); Gari, M.; Zabolitzky, J. G. Phys. Lett.; 38B: No. 4, 189-92(21 Feb 1972). Contract AT(04-3)-63.

The irregular alpha decay from the 3^+, T = 0 11.06-MeV state in ^{16}O is calculated in the Cabbibo model of weak interactions. If short-range correlations are included in the calculation via the generalized Bethe–Goldstone equation, this process seems to be a very favorable one: $\Gamma^{1r} \approx 3 \times 10^{-6}$ eV. (auth)

21658 STRUCTURE OF ^{8}Be AND ITS RELEVANCE TO THE FISSION PROBLEM. Harvey, M.; Jensen, A. S. (Chalk River Nuclear Labs., Ont.) Nucl. Phys.; A179: No. 1, 33-50(1972).

The structure of ^{8}Be is examined in the spherical shell model, the deformed shell model, the cluster model and the cluster model with the one- and three-dimensional generator coordinate techniques. The increase in binding energy with each sophistication is discussed. The collectivity of each model is demonstrated through the B(E2) in the projected states. A new method of generating clusters is presented which could have relevance for the fission problem. (auth)

21659 SEARCH FOR QUASIMOLECULES IN HEAVY-ION REACTIONS IN THE REGION OF THE COULOMB BARRIER. Voit, H.; Ischenko, G.; Siller, F.; Helb, H.-D. (Univ., Erlangen, Ger.). Nucl. Phys.; A179: No. 1, 23-32(1972).

Resonant structures of the well-known ^{12}C-^{12}C type in the excitation functions of some selected heavy-ion reactions were studied. The reactions investigated are ^{12}C(^{13}C,α)^{21}Ne, ^{12}C(^{13}C,p)^{24}Na; ^{12}C(^{14}N,α)^{22}Na, ^{12}C(^{14}N,p)^{25}Mg; ^{10}B(^{14}N,α)^{20}Ne and ^{10}B(^{14}N,^{12}C)^{12}C. The excitation functions have been measured using thin targets of 10–15 μg/cm^2 in small energy intervals of 50–100 keV in the region of the Coulomb barrier. The excitation functions show no evidence for correlated structure as measured in the ^{12}C-^{12}C system. (auth)

21660 REACTION MECHANISM AND SYMMETRY AXES IN PARTICLE–PARTICLE CORRELATIONS. Lang, J.; Valley, J. F.; Mueller, R.; Marmier, P. (Eidgenoessiche Technische Hochschule, Zurich). Phys. Rev. Lett.; 28: No. 10, 623-5 (6 Mar 1972).

The conjecture that a determination of the axis of symmetry in a sequential decay provides the necessary information to select the reaction mechanism is discussed. Experimental results and a distorted-wave Born-approximation analysis are given for the reaction ^{12}C(d,n)^{13}N*(p)^{12}C. (auth)

21661 OBSERVATION OF THE 14 MeV RESONANCE IN ^{12}C(p,p)^{12}C WITH MOLECULAR ION BEAMS. Bacher, A. D. (Univ. of California, Berkeley); McClatchie, E. A.; Zisman, M. S.; Weaver, T. A.; Tombrello, T. A. Nucl. Phys.; A181: No. 2, 453-64(1972).

The lowest T = $\frac{3}{2}$ state in ^{13}N was observed using H_2^+ and H_3^+ molecular ion beams incident on ^{12}C. The dependence of the shape of the observed anomaly on the molecular-ion species and the target thickness is accounted for by using the parameters of the molecular ions and a standard resonance shape determined by using a proton beam. In addition to explaining the interaction of molecular ion beams with a thin target, these results provide a technique for extending precise energy-calibration standards to significantly higher energies. (auth)

21662 SEARCH FOR THE BOUND TRINEUTRON. Koral, Kenneth Francis. Cleveland; Case Western Reserve Univ. (1971). 102p. University Microfilms Order No. 72-65.

Thesis.

A search was made for bound trineutrons produced by bombardment of a natural-lithium target with 19 MeV neutrons. Direct detection of the trineutrons at forward reaction angles was attempted

with a helium-recoil scintillator. Trineutrons could be partially separated from a background of neutrons by correlating the time of flight between target and detector with the pulse height produced by the recoiling ^{4}He ion in the detector. A background run with a carbon dummy target was also taken and the results compared with those for the lithium target. No evidence for the existence of a trineutron was found over a binding-energy range of ~0 to 7 MeV. For the ^{7}Li(n,^{3}n)^{5}Li reaction, the upper limit for the differential cross section is 0.1 mb/sr and the estimated limit for the total cross section is 1 mb. For the two-step reaction, ^{7}Li (n,^{7}He)p, ^{7}He → ^{3}n + ^{4}He, the upper limit for the differential cross section is 0.8 mb/(sr MeV) and the estimated limit for the total cross section is 10 mb. These limits reaffirm the limit determined by Fujikawa and Morinaga for the same reactions. Since the approximate theoretical value for the total cross section of ^{7}Li(n,^{3}n)^{5}Li is 1.0 mb, these limits cast further doubt upon the existence of the bound trineutron. (Diss. Abstr. Int., B)

21663 ELASTIC SCATTERING OF α-PARTICLES ON ^{10}B FOR E_α = 5 TO 30 MeV. David, P.; Debrus, J.; Mommsen, H.; Riccato, A. (Univ., Bonn). Nucl. Phys.; A182: No. 2, 234-46 (1972).

The elastic scattering of α particles by ^{10}B was measured in the energy interval between 5 and 30 MeV. At forward angles a diffraction pattern is observed in the energy range from 12 to 30 MeV, while at backward angles a strong rise of the cross section is seen. The diffraction pattern is interpreted in a Regge-pole diffraction model. The measured behavior of the cross section at backward angles may be attributed to 1 poles in the partial-wave scattering amplitude corresponding to a partial-wave resonance or to angular momentum mismatch between the elastic and absorption channels. (auth)

21664 REACTIONS ^{7}Li + n, ^{7}Li + p, AND EXCITED STATES OF THE A = 8 SYSTEM. Presser, G.; Bass, R. (Univ., Frankfurt am Main). Nucl. Phys.; A182: No. 2, 321-41(1972).

Integral cross sections for the analogous reactions ^{7}Li(n,n$_1$)^{7}Li, ^{7}Li(p,p$_1$)^{7}Li and ^{7}Li(p,n$_1$)^{7}Be were obtained for neutron energies between 1.0 and 9.0 MeV and for proton energies between 2.0 and 6.0 MeV by observing the γ radiation emitted from the final states with Ge(Li) detectors. In addition, some (n,n$_1$) cross sections on ^{7}Li were measured for neutron energies around 20 MeV. The (n,n$_1$) excitation function was analyzed in the framework of resonance theory, together with existing information on the elastic scattering of neutrons from ^{7}Li. Two states in ^{8}Li with the parameters $E_x(^8Li)$ = 5.53 MeV, Γ = 0.66 MeV and $E_x(^8Li)$ = 6.40 MeV, Γ = 1.14 MeV were clearly observed. The results for ^{7}Li + p and the question of isospin mixing in ^{8}Be are discussed in a qualitative manner. (auth)

21665 MAGNETIC MOMENT OF THE FIRST EXCITED STATE OF ^{10}B. Avida, R.; Ben-Zvi, I.; Goldring, G.; (and others) (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A182: No. 2, 359-68(1972).

The magnetic moment of the 1$^+$ first excited state of ^{10}B at 0.72 MeV was determined by an integral perturbed angular correlation measurement in an external magnetic field. The value obtained for the g-factor, +0.63 ± 0.12, is compared with calculations based on the effective-force treatment of ^{10}B. A measurement of the perturbation produced in ^{10}B nuclei implanted in iron showed that the internal field H_{int} at the boron nuclei was less than 4 kG. (5 figures, 3 tables) (auth)

21666 EXPERIMENTAL STUDY OF THE ^{6}Li(n,p)^{6}He REACTION. Merchez, F. (Institut des Sciences Nucleaires, Grenoble, France); Bouchez, R.; Yavin, A. I. Nucl. Phys.; A182: No. 2, 428-32(1972).

Angular distributions for the ^{6}Li(n,p)^{6}He(g.s.) reaction were measured at 14 MeV and compared with previously reported ^{6}Li(p,p')^{6}Li (3.56 MeV) results and with ^{6}Li(p,n)^{6}Be(g.s.) data. These three $\Delta T = \Delta S = 1$ angular distributions are similar in shape, and the ratios of cross sections agree with the hypothesis of charge independence. Existing data, which display an energy dependence of the angular distributions for these transitions, are also presented. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 38

Refer also to abstracts 20488, 21633, 21641, 21647, 21649, 21656, 21748, 21838, and 21841.

21667 (EURFNR-979) MEASUREMENT OF HIGH RESOLUTION γ-RAY PRODUCTION CROSS SECTIONS IN INELASTIC NEUTRON SCATTERING ON Al AND Fe BETWEEN 0.8 AND 13 MeV. Voss, F.; Cierjacks, S.; Kropp, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Mar 1971. 11p. (KFK-1494; CONF-710301-16). Dep. NTIS (U. S. Sales Only).

From third conference on neutron cross sections and technology; Knoxville, Tenn. (15 Mar 1971).

Work performed under United States–Euratom Fast Reactor Exchange Program.

Differential cross sections for the production of γ rays by [n,n'ν] reactions in aluminum and iron were measured at 125° as a function of the incident neutron energy from 0.8 to 13 MeV. The Karlsruhe isochronous cyclotron was used to produce a pulsed beam of neutrons having a continuous energy spectrum from ~0.5 to 30 MeV. The γ-ray energies were measured using a Ge(Li) detector. The incident neutron energies were determined by the time-of-flight technique. The energy resolution obtained in this measurement was ≤1.7 keV at 0.8 MeV and ≤110 keV at 13 MeV, respectively. Neutron flux determination was accomplished by use of a calibrated proton recoil detector. Below approximately 3 MeV the results can be used to determine inelastic scattering cross sections for the excitation of six levels in aluminum and five levels in iron. A comparison of the presented results with other available data is shown and discussed. (auth)

21668 (IS-T-493) APPLICATIONS OF POINT GROUP SYMMETRIES IN LIGHT NUCLEI. Hauge, Paul Stephen (Ames Lab., Iowa). Nov 1971. Contract W-7405-eng-82. 230p. Dep. NTIS. Thesis.

Various properties of the low-lying energy levels of many light nuclei are studied within the framework of two different types of α-particle models. The first model considered is the classical α-particle (CAP) model, which assumes that light A = 4N nuclei (where A is the atomic number and N is an integer) are composed entirely of permanent alpha particles arranged in a definite molecular-like structure. The ^{20}Ne nucleus is found to be a D_{2d} distorted tetrahedron in agreement with earlier investigations. Electron scattering form factors are predicted, but there are at present no experimental data for comparison. Most interesting results are obtained for ^{24}Mg, where the experimental matrix elements, energy spectrum, and electron scattering form factors are found to definitely favor a D_{2h} bitetrahedron over the D_{4h} square bipyramid used previously. Recent experiments on ^{28}Si are also found to slightly favor an oblate D_{3d} structure over the previously considered D_{5h} pentagonal bipyramid. No definite structures can be established for ^{32}S and ^{36}Ar because of the large number of alpha particles involved. A unique structure is, however, found for ^{40}Ca, which consists of six alpha clusters arranged in an octahedron outside of a tetrahedral ^{16}O core. The second α-particle model considered is called the unified α-particle (UAP) model and applies only to light A = 4N + 1 nuclei. In this model, the first 4N nucleons are assumed to form a deformed α-cluster core, and the last nucleon then populates the single-particle states which arise from the resultant potential of the core. The theory is developed in a straightforward manner paralleling that of the unified symmetric rotor model. The UAP model is then applied, with reasonably good success, to the mass A = 9 and 13 nuclei. (auth)

21669 (NP-19178) GAMMA RAY STUDIES IN ^{27}Al AND ^{29}Al. Carter, Keith William (Australian National Univ., Canberra). Dec 1970. 199p. Dep. NTIS (U. S. Sales Only). Thesis.

Gamma ray decay schemes and angular correlation measurements of excited states of ^{27}Al and ^{29}Al indicated that ^{29}Al could be interpreted in terms of the Nilsson model assuming a prolate deformation of the 2s–1d shell. Several ^{27}Al properties suggested rotational character but no consistent interpretation in terms of a simple Nilsson model was possible. Angular correlation studies of ^{27}Al between 3.68 and 4.58 MeV were made from the ^{24}Mg(α,pγ)^{27}Al reaction. Branching ratio measurements were made from ^{13}C(^{16}O,p)^{27}Al between 5.50 and 7.44 MeV and together with angular correlation studies of the 5.50 and 7.44 MeV levels enabled probable spin assignments of $^{11}/_2$(5.50); $^9/_2$(6.72); $^{11}/_2$(6.95); $^{11}/_2$ or $^{13}/_2$ (7.17); $^9/_2$ or $^{11}/_2$(7.23); and $^{13}/_2$(7.44 MeV). Branching ratio and angular correlation measurements between 1.40 and 3.44 MeV were obtained for ^{29}Al using ^{26}Mg(α,pγ)^{29}Al. (Australia)

21670 ISOTOPIC ABUNDANCE OF NEON, ARGON, AND KRYPTON. Melton, Charles E.; Massey, W.; Abels, B. N. (Univ. of Georgia, Athens). Z. Naturforsch.; 26a: No. 7, 1241-2 (Jul 1971).

Two research mass spectrometers combined with careful experimental techniques have been used to redetermine the isotopic abundances of atmospheric neon, argon and krypton. No instrumental correction factor was necessary to duplicate the known results for neon. The new isotopic abundance of argon is essen-

tially identical to that previously obtained by Nier. On the other hand, some differences in the present and previous values were noted in the isotopic abundance of krypton. The new values for the nuclides of krypton are $^{78}Kr = 0.355 \pm 0.001$, $^{83}Kr = 11.536 \pm 0.009$, $^{80}Kr = 2.256 \pm 0.007$, $^{84}Kr = 56.982 \pm 0.01$, $^{82}Kr = 11.553 \pm 0.009$, $^{86}Kr = 17.318 \pm 0.009$. The atomic weight calculated on the basis of these new values and $^{12}C = 12.0000$ is 83.8005 ± 0.001 amu. (auth)

21671 DETERMINATION OF THE DEFORMATIONS IN ^{24}Mg AND ^{28}Si NUCLEI FROM ELECTRON SCATTERING. Nakada, Akira; Torizuka, Yoshiharu (Tohoku Univ., Sendazi). J. Phys. Soc. Jap.; 32: No. 1, 1-13(Jan 1972).

High-resolution measurements of the differential cross sections for elastic and inelastic scattering of 183- and 250-MeV electrons by ^{24}Mg and ^{28}Si were carried out using the beams from the Tohoku 300-MeV electron linear accelerator. Several excitations for these nuclei including the members of the ground-state rotational band were found. The inelastic cross sections obtained were analyzed to extract the B(EL) values. The form factors for the rotational levels were further analyzed by the use of the extended Nilsson model and found the best fits to the data. The quadrupole and hexadecapole moments are also extracted from this analysis. The parameters β_2 and β_4 associated with the nuclear Y_2 and Y_4 deformations are calculated from these moments and compared with those obtained from (p,p') reactions. (auth)

21672 QUADRUPOLE AND HEXADECAPOLE DEFORMATION OF 2s-1d SHELL NUCLEI. Rebel, H. (Kernforschungszentrum, Karlsruhe, Ger.); Schweimer, G. W.; Schatz, G.; (and others). Nucl. Phys.; A182: No. 1, 145-73(1972).

Differential cross sections are measured for the elastic and inelastic scattering of 104 MeV α particles from ^{20}Ne, ^{22}Ne, ^{24}Mg and ^{28}Si. The experimental results are analyzed in terms of coupled channels on the basis of the rotational model and prove to be quite sensitive to both the magnitude and sign of the quadrupole and hexadecapole deformation. The extracted β_4 deformation parameters show a systematic trend through the region A = 20-28. Prolate shapes of ^{20}Ne, ^{22}Ne and ^{24}Mg, and the oblate shape of ^{28}Si are confirmed. The (α,α') scattering results are compared to results of other experimental and theoretical investigations. (auth)

21673 STUDY OF ELECTROMAGNETIC TRANSITIONS IN ^{37}Ar. Ragan III, Charles Ellis. Durham, N. C.; Duke Univ. (1971). 166p. University Microfilms Order No. 72-330.

Thesis.

The mean lifetimes of the levels of ^{37}Ar below 3.0 MeV excitation energy have been measured using the Doppler shift attenuation method (DSAM). The levels were populated by the endothermic $^{34}S(\alpha,n)^{37}Ar$ reaction ($Q_0 = -4.629$ MeV). A 450 $\mu g/cm^2$ CdS target (enriched to 85.61% in ^{34}S) evaporated onto a 1μ Ni foil was bombarded with α particles ranging in energy from 7.6 to 8.8 MeV. Gamma rays were detected at 0, 37, 45, 55, 90, and 143° to the beam axis with a 30-cc Ge(Li) detector. The following mean lifetimes were found: τ(1.41-MeV level) = $1.08^{+0.10}_{-0.13}$ psec, $\tau(2.22) = 380 \pm 50$ fsec, $\tau(2.49) = 775 \pm {}^{+150}_{-100}$ fsec, and $\tau(2.80) = 14 \pm 11$ fsec. Excitation energies for the first five excited states were determined from the ground state transitions. All five levels were found to γ decay 100% to the ground state and upper limits were set on other possible transitions. The angular distributions of the γ rays were measured. Analysis of these distributions for the levels at 1.41, 1.61, and 2.49 MeV gave spins in agreement with previous assignments. On the basis of the angular distribution and the lifetime a most probable spin-parity of $(^7/_2{}^+)$ was assigned to the 2.22-MeV level. The mean lives of the positive parity states are in good agreement with those predicted from many particle shell-model calculations. A full description of the DSAM is presented along with a description of the energy loss of heavy ions in matter. (Diss. Abstr. Int., B)

21674 DETERMINATION OF MIXING RATIOS IN ^{27}Mg BY $\gamma-\gamma$ GONIOMETER. Costa, G.; Beck, F. A. (CRN, Strasbourg). pp 224-6 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Gamma angular distributions and $\gamma-\gamma$ angular correlations from the $^{26}Mg(d,p\gamma)$ reaction were studied to obtain the multipole mixing ratio for the 984-keV transition. Gamma angular distributions were measured with a Ge(Li) detector and the angular correlations were measured with a multi-counter goniometer. A mixing ratio of -0.22 ± 0.02 was obtained. (J.W.R.)

21675 STUDIES OF THE PROPERTIES OF ^{29}P LEVELS. Beck, F. A.; Byrski, T.; Engelstein, P.; Knipper, A.; Gorodetzky, S. (CRN, Strasbourg). pp 226-9 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Gamma angular distributions and $\gamma-\gamma$ angular correlations from the $^{28}Si(p,\gamma)$ reaction were measured in order to obtain information on ^{29}P levels. A level scheme of ^{29}P, including spins and transition multipolarities was developed. (J.W.R.)

21676 DETERMINATION OF THE MIXING RATIO IN THE DECAY OF THE LONG-LIVED 1.612 MeV LEVEL IN ^{37}Ar. Taras, P.; Matas, J.; Turcotte, A.; Vaillancourt, R. (Univ. of Montreal). pp 229-31 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The angular distribution and polarization of γ-rays from the decay of the 1.612-MeV level in ^{37}Ar were measured using the $^{37}Cl(p,n)$ reaction at proton energies of 3.98 and 4.38 MeV. The simultaneous measurement of the angular distribution and polarization eliminates the effects of perturbations caused by the long lifetime of the state. The M2/E3 mixing ratio was deduced for the 1.612 MeV ($^7/_2$) to ($^3/_2$) ground state transition. (J.W.R.)

21677 g-FACTOR OF THE $^7/_2{}^-$ LEVEL AT 1.611 MeV IN ^{37}Ar. Haag, D. W.; Leitz, W.; Michaelsen, R.; Ribbe, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 569-71 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The g-factor of the $^7/_2{}^-$ 1.611-MeV level in ^{37}Ar was measured by the method of time-differential observation of the rotation of the γ-ray pattern in a magnetic field. The γ rays were analyzed with respect to energy and time delay following the excitation of ^{37}Ar by the $^{37}Cl(p,n)$ reaction with pulsed protons. A preliminary measurement of the g-factor for ^{37}K $^7/_2{}^-$ state was also made. The g-factors for the two $^7/_2{}^-$ states are compared with the mirror theorem of Sachs. (J.W.R.)

21678 MEAN LIFETIMES OF THE 3.38 AND 4.59 MeV LEVELS OF ^{38}Ar. Kern, B. D.; Bond, P. D. (Stanford Univ., Calif.). Nucl. Phys.; A181: No. 2, 403-8(1972).

The recoil-distance Doppler-shift method was used to measure the lifetimes of two levels of ^{38}Ar, produced by the $^4He(^{35}Cl,p)^{38}Ar$ reaction. A gas target at 200 to 400 torr pressure was used. The mean lifetime of the 3377-keV level was determined as 27 ± 3 ps. The mean lifetime of the 4585-keV level was determined as 172 ± 8 ps through observation of the 105-keV γ rays which are emitted from this level and of the subsequently emitted 670-keV γ rays. (3 figures) (auth)

21679 MEASUREMENT OF THE REACTION TIME FOR THE $^{27}Al(p,\alpha)^{24}Mg$ REACTION BY THE USE OF THE BLOCKING EFFECT. Komaki, K. (Tokyo Univ.); Fujimoto, F.; Nakayama, H.; Ishii, M.; Hisatake, K. Phys. Lett.; 38B: No. 4, 218-19 (21 Feb 1972).

The reaction times for the $^{27}Al(p,\alpha)^{24}Mg$ reaction at incident proton energies of 633 and 1183 keV were measured by the use of the blocking method. For the 633-keV resonance the measured reaction time is 0.136 ± 0.012 fs. (auth)

21680 $(p,n\gamma)$ REACTION ON ^{27}Al AND ^{28}Si. Moss, C. E.; King, N. S. P.; Comiter, A. B.; Ristinen, R. A. (Univ. of Colorado, Boulder). Nucl. Phys.; A179: No. 1, 89-100(1972).

The reactions $^{27}Al(p,n\gamma)^{27}Si$ and $^{28}Si(p,n\gamma)^{28}P$ have been studied at $E_p = 16$ and 23 MeV, respectively, with a Ge(Li) detector in coincidence with a neutron detector. In ^{27}Si, two new γ-transitions were detected and accurate excitation energies were determined. In ^{28}P, the γ-decay scheme was studied for the first time and new levels were located at 879 and 1602 keV excitation energy. For both nuclei the γ-ray spectra were supplemented by neutron time-of-flight spectra. The excitation energies are compared with those of the analog nuclei and with the predictions from Coulomb displacement calculations. (auth)

21681 LIFETIMES OF STATES IN ^{28}Si, ^{27}Al, AND ^{26}Mg. McDonald, A. B.; Alexander, T. K.; Haeusser, O.; Ewan, G. T. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 49: No. 23, 2886-97(1 Dec 1971). (AECL-4015).

The recoil-distance method was used to measure the lifetimes of the ^{29}Si, 3626 keV ($^7/_2{}^-$) level (4.2 ± 0.5 ps) from the $^{12}C(^{19}F,n\rho\gamma)$ ^{29}Si reaction, the ^{26}Mg, 1809 keV (2^+) level (0.7 ± 0.3 ps) from the

$^{12}C(^{19}F,\alpha p\gamma)^{26}Mg$ reaction, and the ^{27}Al, 843 keV ($\frac{1}{2}^+$) level (45 ± 6 ps) from the $^{27}Al(^{35}Cl,^{35}Cl)^{27}Al$ Coulomb excitation reaction. The Doppler shift attenuation method was employed to determine the lifetime of the ^{27}Al, 1013 keV ($\frac{5}{2}^+$) level ($2.2^{+\beta}_{-\beta}$ ps) from the line shape for thick target Coulomb excitation by 67 MeV ^{35}Cl. The results are compared with model predictions. (auth)

21682 SPINS OF LEVELS IN ^{32}P BY ANGULAR-CORRELATION STUDIES. St.-Pierre, C.; Gagnon, R.; Gill, G. S. (Laval Univ., Quebec). Can. J. Phys.; 49: No. 23, 2931-7(1 Dec 1971).

The spectroscopic properties of the 1.75, 2.66, 2.74, and 3.00 MeV levels of ^{32}P were studied by the particle–gamma angular-correlation method II of Litherland and Ferguson applied to the reaction $^{29}Si(\alpha,p)^{32}P$ at 10.3 MeV. The decay scheme was observed with a Ge–Li detector in coincidence with the protons. The spin of the 1.75 MeV level was determined to be 3. The restrictions imposed on J by the analysis of the angular correlations combined with other information lead to the following most probable assignments: 2.66 MeV, J = 1,2; 2.74 MeV, J = 1,2; 3.00 MeV, J = 1,2,3. (auth) (Canada)

21683 ANGULAR CORRELATIONS AND DECAY OF EXCITED STATES IN ^{35}S. van der Mark, Th. W.; ter Veld, L. K. (Rijksuniversitet, Groningen, Netherlands). Nucl. Phys.; A181: No. 1, 196-206(1972).

The $^{34}S(d,p\gamma)^{35}S$ reaction has been used to populate levels in ^{35}S. Particle–γ angular-correlation measurements have been performed for energy levels up to 3 MeV excitation energy. Restrictions on possible spin assignments and multipole-mixing ratios are deduced. The γ-ray decay of higher excited states in ^{35}S has been studied with the $^{37}Cl(d,\alpha\gamma)^{35}S$ reaction. A previously unobserved level has been located with an excitation energy of 3821 keV. (auth)

21684 CHANNEL-COUPLING EFFECTS IN ANALOG CHARGE-EXCHANGE REACTIONS. Madsen, V. A. (Oregon State Univ., Corvallis); Stomp, M. J.; Brown, V. R.; (and others). Phys. Rev. Lett.; 28: No. 10, 629-32(6 Mar 1972).

Data and coupled-channel calculations on charge-exchange reactions in ^{56}Fe and ^{26}Mg to 0^+ and 2^+ analog states are presented. For the (p,n) reaction in the neighborhood of 20 MeV the two-step processes dominate the excited 2^+ analog transitions, this domination explaining the large strength of these states in the (p,n) spectrum. The two-step mechanism is relatively weaker but still important in the corresponding (^{3}He,t) reaction. (auth)

21685 OBSERVATION OF NUCLEAR γ RAYS FROM KAON CAPTURE. Wiegand, Clyde E.; Gallup, Jeffrey M.; Godfrey, Gary L. (Univ. of California, Berkeley). Phys. Rev. Lett.; 28: No. 10, 621-3(6 Mar 1972).

Nuclear γ rays from kaons captured at rest in S and Cl were observed. The γ rays correspond to the first excited state of ^{32}P, 78.1 keV, and the first two levels of ^{19}F, 110 and 197 keV. (auth)

21686 A NEW NUCLIDE: ^{35}P. Grimm, W.; Herzog, W. (Johannes-Gutenberg-Univ., Mainz). Z. Naturforsch.; 26a: No. 11, 1933-4(Nov 1971). (In German).

The new nuclide ^{35}P was produced by the reaction $^{37}Cl(\gamma,2p)^{35}P$ and a half-life of 45 ± 2 s and a γ-ray with an energy of 1571.8 ± 0.2 keV were measured. (auth)

21687 TRIAXIAL STATES OF LIGHT NUCLIDES. Ruehl, F. R. Jr. (Univ. of California, Los Angeles). Acta Phys. Acad. Sci. Hung.; 30: No. 3, 283-92(1971).

The triaxial shapes of the first excited state of ^{16}O and of the ground states of ^{24}Mg and ^{32}S are studied in detail. Multipartite nucleon–nucleon interaction potentials, coupling Wigner central forces to Majorana exchange forces with both having Gaussian radial dependence, are employed in a variational calculation carried out in a Cartesian harmonic oscillator basis of states. Among the fundamental nuclear quantities computed are binding energies, equilibrium oscillator energies, quadrupole moments Q_0 and Q_2, monopole moments, B(E2) transition probabilities, and root-mean-square radii. For ^{16}O, ample comparisons are made between the ground and excited states; while for ^{24}Mg and ^{32}S, comparisons are made among the oblate, prolate, and triaxial shapes of the ground states of this pair of nuclides. (auth)

21688 STATES IN ^{28}Si STUDIED THROUGH THE $^{27}Al(p,\alpha)^{24}Mg$ REACTION AT LOW ENERGIES. Arriola, A.; Lira, J.; Rickards, J.; (and others) (Univ. Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis.; 20: No. 3, 161-70(1971).

The excitation curve for the $^{27}Al(p,\alpha)^{24}Mg$ reaction was measured in the proton energy range of 1.32–2.05 MeV, to study excited states in ^{28}Si. Angular distributions of α_0-particles were measured at 6 of the 11 resonances. The analysis shows good agreement with Abuzeid et al. assignments. Three angular distributions not reported in Abuzeid's work were measured and possible assignments are reported. (auth)

21689 INVESTIGATION OF PROTON-RICH NUCLEI AND OTHER PRODUCTS FROM THE BOMBARDMENT OF ^{24}Mg, ^{28}Si, AND ^{32}S BY ^{16}O IONS. Zioni, J.; Jaffe, A. A.; Friedman, E.; (and others) (Hebrew Univ., Jerusalem). Nucl. Phys.; A181: No. 2, 465-76(1972).

The β- and γ-ray spectra resulting from the bombardment of ^{24}Mg, ^{28}Si, and ^{32}S with continuous and chopped beams of ^{16}O ions were studied in the energy range of 22 to 33 MeV. Compound-nucleus formation is found to predominate in the reactions. Proton-rich nuclei are observed via the (^{16}O, 2n) reaction in each case. In particular, the mass excess of the previously unobserved nucleus ^{46}Cr is found to be –29.46 ± 0.03 MeV; its half-life is 0.26 ± 0.06 s. The systematics of the Coulomb displacement energies of the mass triplets up to A = 46 are discussed. (auth)

21690 MAGNETIC MOMENT OF β EMITTER ^{29}P. Sugimoto, K.; Mizobuchi, A.; Minamisono, T. (Osaka Univ.). pp 325-31 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

NMR on polarized ^{29}P was studied in Si implanted through the $^{28}Si(d,n)$ reaction. The uncorrected magnetic moment was determined to be 1.23374 ± 0.00009 nm in red-P and 1.23356 ± 0.00003 nm in Si. The moment with the diamagnetic correction is 1.2349 ± 0.0003 nm. The magnetic moments and the β-decay ft value for the doublets were analyzed, and the expectation values of the spin and orbital angular momenta are plotted for pairs of isospin doublets. (D.L.C.)

21691 DEORIENTATION MEASUREMENT IN ^{20}Ne. Faessler, M.; Povh, B.; Schwalm, D. (Univ., Heidelberg. Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 968-9 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The velocity dependence of the deorientation effect was investigated for ^{20}Ne ions recoiling into vacuum from the reaction $^{12}C(^{12}C,\alpha)^{20}Ne^*$. The $\alpha-\gamma$ angular correlation for the first excited state of ^{20}Ne was measured. By comparing the perturbed angular correlation to the unperturbed one, the attenuation factors G_2 and G_4 were determined. The measured attenuation factors $(1-G_4)$ as a function of the velocity v/c of the Ne ions $[1-G_2 \approx 0.3(1-G_4)]$ can be explained by assuming a static, magnetic interaction between the nucleus and its surrounding electrons. A curve was calculated assuming the magnetic field to be caused by the 1s electrons of the Ne^{9+} ions only (H = 170 MG, g = 0.5). In other curves (g = 0.5 and 0.7), the contributions of other possible electron configurations were taken into account. (D.L.C.)

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Refer also to abstracts 21548, 21649, 21667, 21668, 21670, 21684, 21722, 21739, 21748, 21777, and 21841.

21692 (FRNC-CONF-10) (p,α) REACTIONS OF EVEN Ca ISOTOPES AT 56.6 MeV. Martin, P.; Dupont, Y.; Chabre, M. (Grenoble Univ. (France). Institut des Sciences Nucleaires). 25 May 1971. 4p. (CONF-710447-1). Dep. NTIS (U. S. Sales Only).

From Conference on $f\frac{7}{2}$ shell nuclei; Padova, Italy (15 Apr 1971).

Some (p,α) reactions with even Ca nuclei were studied at E_p = 56.6 MeV. Absolute cross sections were measured between 10 and 50°. A pick-up reaction probably takes place. (France)

21693 (JUL-790-NP) TWO-DIMENSIONAL COINCIDENCE APPARATUS FOR MEASUREMENT OF $\gamma\gamma$ ANGULAR CORRELATIONS AFTER NEUTRON CAPTURE AND THE EXPERIMENTAL INVESTIGATION OF THE LOW-ENERGY EXCITATION STATES IN ^{46}Sc WITH THE HELP OF THE REACTION $^{45}Sc(n,\gamma)^{46}Sc$. Delang, Winfried (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik). Aug 1971. 92p. (In German). Dep. NTIS (U. S. Sales Only).

The reaction A(n,γ) A + 1 permits the investigation of excited levels which were not populated in radioactive decay by the γ spectroscopic method. A coincidence apparatus for the measurement of the $\gamma\gamma$ angular correlation after neutron capture was de-

veloped. By the use of 2 ADC's together with the recording of coincidence events on magnetic tape it is possible to measure the angular distribution of all cascades in the spectrum. With the help of this apparatus coincidence and angular correlation measurements were made on ^{46}Sc. The previously known decay scheme could be significantly expanded. The spins of all levels were determined within 2 MeV or limited between two possible values. Mixing parameters were determined for some intensive transitions. A comparison of the results with the theoretical results show that in addition to the configuration $f_{\frac{7}{2}}^n$ additional configurations are necessary for the description of the low energy excitation states in ^{46}Sc. For some low-lying states of negative parity other authors proposed rotation states as an interpretation. This explanation is not in contradiction to the additional information obtained in the measurement of the ^{46}Sc spectrum. (tr-auth)

21694 (NYO-4032-70) EFFECTIVE WAVE FUNCTION CALCULATION OF THE $J^\pi = 0^+$ STATES OF THE Ca-ISOTOPES THROUGH THE (t,p) AND (p,t) REACTIONS. Broglia, R. A. (Niels Bohr Institutet, Copenhagen (Denmark). State Univ. of New York, Stony Brook. Inst. for Theoretical Physics); Kolltveit, K. (Michigan State Univ., East Lansing. Dept. of Physics. Bergen Univ. (Norway). Dept. of Physics); Nilsson, B. (Nordisk Institut for Teoretisk Atomfysik, Copenhagen (Denmark). State Univ. of New York, Stony Brook. Dept. of Physics). [1970]. Contract *AT(30-1)-4032. 14p. Dep. NTIS.

The amplitudes of the spherical and deformed components of the $J^\pi = 0^+$ states of the Ca-isotopes connected by (t,p) and (p,t) reactions are considered as variational parameters and are determined by fitting the corresponding two-neutron transfer reaction cross sections. The influence of the deformed components in these reactions is assessed. Utilizing finite range results and appropriate wave functions the absolute value of the cross sections is reproduced. (auth)

21695 POLARIZING PROPERTIES OF NUCLEI OF AVERAGE ATOMIC WEIGHT FOR 1.5 MeV NEUTRONS. Korzh, I. A.; Kostyuk, T. A.; Mishchenko, V. A.; Pravdivyi, N. M.; Sanzhur, I. E. (Inst. of Nuclear Research, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 4, 823-9(Apr 1971). (In Russian).

Using partially polarized neutrons from the reaction $T(p,n)^3He$, data on the angular dependence of polarization of elastically scattered polarized 1.5-MeV neutrons were obtained over the angular interval 20 to 145° for the following nuclei: Ti, Cr, Fe, Co, Ni, Cu, Zn, Zr, Nb, and Mo. The differential cross section was obtained for nonpolarized neutrons. The elastic scattering cross section and the transport cross section were also measured. The experimental data on the differential cross section and neutron polarization were analyzed on the basis of a six-parametric optical model of the nucleus. (tr-auth)

21696 keV RESONANCE NEUTRON CAPTURE IN IRON. Kenny, M. J. (Australian Atomic Energy Commission Research Establishment, Sutherland). Aust. J. Phys.; 24: No. 6, 805-19 (Dec 1971).

Resonance behavior has been observed at a number of neutron energies between 5 and 90 keV. Transition intensities show strong fluctuations with neutron energy. The presence of p- and/or d-wave capture is inferred from the occurrence of transitions to high spin states. A distribution of reduced widths for low spin states suggests some departure from statistical processes, particularly for the strongest transitions. (auth) (Australia)

21697 ^{39}K 2.82 MeV LEVEL. Robertson, B. C. (Univ. of Alberta, Edmonton). Can. J. Phys.; 49: No. 23, 3051-2 (1 Dec 1971). (UAE-NPL-1031).

Experimental M2 and E3 radiation widths for the 2.82-MeV level in ^{39}K are obtained from available data and compared with theoretical predictions. It is shown that a large collective octupole admixture is not necessary to reproduce the E3 width and an inhibited M2 width is indicated, which is most likely due to the presence of 2 particle-3 hole components in the ground-state wave function. (auth) (Canada)

21698 MEASUREMENTS OF STATIC ELECTRIC QUADRUPOLE MOMENTS IN ^{48}Ti, ^{56}Fe, ^{58}Ni, AND ^{60}Ni. Lesser, Peter Michael Sapir. Rochester, N. Y.; Univ. of Rochester (1971). 250p. University Microfilms Order No. 72-737.

Thesis.

The static electric quadrupole moments of the first excited (2^+) states of ^{48}Ti, ^{56}Fe, ^{58}Ni and ^{60}Ni were measured using the reorientation effect in Coulomb excitation. Self-supporting thin foil targets were bombarded with 60 to 70 MeV ^{32}S ions and the scattered particles were detected in coincidence with deexcitation gamma rays following Coulomb excitation of the first excited state. A multiple particle-gamma coincidence technique, permitting simultaneous operation of four particle and four gamma detectors, was used for these measurements. Both scattered projectiles and recoiling target nuclei were detected in the forward angle particle detectors and an annular detector was used to detect backscattered projectiles. With this technique it was possible to measure relative cross-sections simultaneously at several widely different center-of-mass scattering angles. The measured cross sections were compared with calculations using the de Boer-Winther multiple Coulomb excitation code, in order to extract static quadrupole moments. Calculations of the gamma angular distributions included relativistic corrections for recoil motion of the target nucleus. In addition, it was necessary to correct for the deorientation effect due to magnetic hyperfine interactions, which produced a measurable attenuation of the gamma ray angular distribution. The magnetic hyperfine field was assumed to have a velocity dependence of the form $H \propto (\beta)^x$, where β = recoil velocity/c, and $x = 0.66 \pm 0.18$. The experimental results for static electric quadrupole moments, as well as reduced E2 transition probabilities, have been compared with the predictions of various shell model calculations for nuclei in the 1f-2p shell. The even titanium isotopes, ^{48}Ti and ^{50}Ti, appear to be well described by the $(f_{\frac{7}{2}})^n + (f_{\frac{7}{2}})^{n-1}(p_{\frac{3}{2}},f_{\frac{7}{2}})^1$ shell model calculations, while the agreement for ^{46}Ti is less good. Shell model calculations for ^{56}Fe, allowing $(f_{\frac{7}{2}})^6(p_{\frac{3}{2}},f_{\frac{7}{2}})^2$ configurations, produce excellent agreement with the measured static quadrupole moment; calculated E2 matrix elements for the higher excited 2^+ states in ^{56}Fe were not yet available at the time of writing of this thesis. In the case of the even nickel isotopes, the assumption of an inert ^{56}Ni core appears to be a poor one and there are significant disagreements between theory (shell model calculations) and experiment. Semi-phenomenological collective model calculations predict a strong correlation between the static quadrupole moment of the 2_1^+ state and the energy separation of the 2_1^+ and 4_1^+ states, in even-even nuclei. The present measurements are in excellent qualitative agreement with these predictions. (Diss. Abstr. Int., B)

21699 (τ,p) REACTIONS ON Cr. III. [^{52}Cr(τ,p)^{54}Mn]. Betts, R. R. (Univ. of Pennsylvania, Philadelphia); Hansen, Ole; Pullen, D. J. Nucl. Phys.; A182: No. 1, 69-83(1972).

The level scheme of ^{54}Mn has been studied by means of the ^{52}Cr (^{3}He,p) reaction at incident energies of 15 and 16.5 MeV. Levels up to 7 MeV of excitation have been measured with an energy resolution of 20 keV using the University of Pennsylvania Tandem Van de Graaff and multi-angle spectrograph. The systematics of the angular distribution shapes together with the predictions of distorted-wave calculations enable assignments of angular momentum transfers. These compared with the results of other analyses of ^{54}Mn produce several new spin and parity assignments. The isobaric spin (^{3}He,p) intensity relations are applied to $0^+ \rightarrow 0^+$ transitions to ^{54}Mn states at 2.119 MeV (T = 2) and at 6.151 MeV (T = 3) and it is found that the T = 2 state only takes up $\frac{1}{3}$ of the expected anti-analog strength. The low-lying part of the ^{54}Mn level scheme is discussed and the summed $0^+ \rightarrow 1^+$ (τ,p) transition strength is found to be ≈ 3 times larger than possible inside an f-p configuration space. (auth)

21700 863.6 TO 810.6 keV γ-γ DIRECTIONAL CORRELATION IN ^{58}Fe. Singhal, N. C. (Vanderbilt Univ., Nashville); Ramayya, A. V.; Hamilton, J. H.; Raman, S. pp 231-4 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Directional correlations were measured for the 863.6-810.6 keV cascade in ^{58}Fe following the decay of ^{58}Co in order to resolve discrepancies between previous ^{58}Co and ^{57}Fe(n,γ) measurements. A_2 and A_4 coefficients were measured using both an 810 (gate)-860 (spectrum) and an 860 (gate)-810 (spectrum) arrangement. Large errors were present in the 860 gate measurement. The coefficients from the 810 (gate)-860 (spectrum) analysis are in good agreement with the (n,γ) measurements. (J.W.R.)

21701 LIFETIMES OF THE 26 AND 110 keV LEVELS IN ^{56}Mn. Boulter, J. F.; Prestwich, W. V. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 49: No. 23, 2911-6(1 Dec 1971).

Using thermal-neutron capture on natural manganese targets, delayed coincidence lifetime measurements have been made for the 26 keV level: $T_{\frac{1}{2}} = 8.65 \pm 0.50$ ns, and the 110 keV level: $T_{\frac{1}{2}} = 5.08 \pm 0.15$ ns in ^{56}Mn. A systematic error in the 26 keV lifetime measurement, which arises when the 26 keV level is populated by a γ ray which has cascaded through the delayed 110 keV level, has been examined. The experimental reduced M1 and E2 transition probabilities were calculated for the 26 and 84 keV transitions. The reduced M1 strength for the 26 keV transition and the ground-state magnetic dipole moment of ^{56}Mn have been compared with theoretical results obtained using the magnetic

moments of neighboring odd-A nuclei as the base states. (auth) (Canada)

21702 EFFECT OF A TWO STEP PROCESS IN (τ,t') REACTION. Toyama, M. (Tokyo Inst. of Tech.). Phys. Lett.; 38B: No. 3, 147-50(7 Feb 1972).

The $^{48}Ca(^3He,t')^{48}Sc$ reaction is analyzed by taking into account the twice single nucleon transfer process in which α-particle is formed as an intermediate state. The contribution of this process is predominant and reproduces the absolute value and the angular distribution of the cross section. (auth)

21703 ^{18}O-INDUCED TRANSFER REACTIONS. Siemssen, R. H.; Fink, C. L.; Greenwood, L. R.; Koerner, H. J. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 28: No. 10, 626-9(6 Mar 1972).

^{18}O-induced reactions on ^{40}Ca and ^{54}Fe were studied at 48 MeV. The one- and two-proton pickup reactions were observed with large cross sections. Systematic and unexpected differences are found in the angular distributions to different final states. The reaction $^{40}Ca(^{18}O, ^{14}C)^{44}Ti$ yields spectra remarkably similar to those found in the $(^{18}O, ^{12}C)$ and $(^{20}Ne, ^{16}O)$ reactions. (auth)

21704 NUCLEAR MOMENTS OF THE 67.4-keV LEVEL IN ^{61}Ni. Goering, J. (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch.; 26a: No. 11, 1931-2(Nov 1971).

The hyperfine structure of ^{61}Ni in $NiCr_2O_4$ has been measured with the Moessbauer technique. The magnetic dipole moment and the electric quadrupole moment of the 67.4 keV level in ^{61}Ni have been determined as $\mu = (+0.479 \pm 0.006)\ \mu_N$ and $Q = (-0.20 \pm 0.03)$ b. (auth)

21705 $(^3He,p)$ AND (d,α) REACTIONS TO STATES IN ^{58}Co. Lynn, L. L. (Massachusetts Inst. of Tech., Cambridge); Schaller, R. C.; Barbour, D. A.; Belote, T. A.; Dorenbusch, W. E. Nucl. Phys.; A182: No. 2, 272-89(1972).

The $^{56}Fe(^3He,p)^{58}Co$ and $^{60}Ni(d,\alpha)^{58}Co$ reactions were investigated at 12.0 and 7.0 MeV bombarding energies, respectively, by using the MIT multiple-gap spectrograph. For the $(^3He,p)$ reaction, levels below 6.0 MeV of excitation were observed and analyzed using the DWBA to obtain L values. In the (d,α) reaction, levels up to 3.4 MeV of excitation were observed. A level scheme for ^{58}Co is proposed. The $^{58}Fe(0.0)$ analog was observed, and candidates for the antianalog level are identified. (7 figures, 4 tables) (auth)

21706 DETERMINATION OF ISOMER RATIOS IN VARIOUS PHOTONUCLEAR AND (n,2n) REACTIONS. Voelpel, R. (Justus-Liebig Univ., Giessen, Ger.). Nucl. Phys.; A182: No. 2, 411-16(1972). (In German).

Isomeric cross-section ratios were measured for the reactions $^{45}Sc(\gamma,n)^{44m,g}Sc$, $^{45}Sc(n,2n)^{44m,g}Sc$, $^{85}Rb(\gamma,n)^{84m,g}Rb$, $^{85}Rb(n,2n)^{84m,g}Rb$, and $^{55}Mn(\gamma,3n)^{52m,g}Mn$. The results were compared with the calculated values obtained from the Vandenbosch–Huizenga formalism. In the analysis the level density parameter, a, the pairing energy, δ, and the spin cut-off parameter, σ, were varied. (auth)

21707 EVIDENCE FOR SOME ISOBARIC ANALOG STATES IN ^{55}Co FROM (p,γ) REACTION IN ^{54}Fe. Ahmed, N. (Atomic Energy Centre, Dacca, Pakistan); Rahman, M. A.; Khatun, S.; Awal, M. A.; Sen Gupta, H. M. Lett. Nuovo Cim.; 3: No. 7, 299-302(12 Feb 1972).

Analog states excited by (p,γ) reactions with ^{54}Fe at incident energies of up to 3 MeV were investigated. The excitation function shows a number of strong resonances that can be identified as analogs to the well-known low-lying states in ^{55}Fe. The Coulomb displacement energy for the ^{55}Co–^{55}Fe pair is given; it is consistent with that for neighboring pairs but about 200 keV larger than the predicted value. (1 figure, 2 tables) (R.W.R.)

21708 STRUCTURE OF ^{42}Ca FROM THE $^{40}Ar(\alpha,n\gamma)^{42}Ca$ REACTION. Alenius, N. G. (Chalmers Univ. of Tech., Goteborg); Arnell, S. E.; Skeppstedt, Oe.; Wallander, E.; Sawa, Z. P. Nuovo Cim.; 8A: No. 18, 147-63(1 Mar 1972).

The properties of some excited states of ^{42}Ca formed in the $^{40}Ar(\alpha,n\gamma)^{42}Ca$ reaction at 13.5 MeV incident energy were studied by means of γ-ray spectroscopy. The γ-ray decay modes of high-spin states below 3.37 MeV were obtained from single and coincidence spectra by using Ge(Li) detectors. Spin values are proposed for the states at 1678 keV, $1^1/_2^-$, 2094 keV, $3/_2^{(-)}$, 2249 keV, $5/_2^{(-)}$, and 2755 keV, $1^1/_2^{(-)}$. The possibility is discussed of a $J^\pi = 3/_2^+$ rotational band, consisting of states at 990, 1395, 1902, 2410, 2952, and 3372 keV. (auth)

21709 HIGH RESOLUTION SPECTROSCOPY OF ^{56}Co AND ^{58}Co. Schneider, Martin Joel. Pittsburgh; Univ. of Pittsburgh (1971). 175p. University Microfilms Order No. 72-1114. Thesis.

Levels of ^{56}Co and ^{58}Co below 4 MeV have been studied by the direct $^{58,60}Ni(d,\alpha)^{56,58}Co$, $^{57}Fe(^3He,d)^{58}Co$, $^{54}Fe(^3He,p)^{56}Co$ and $^{58}Co(^3He,\alpha)^{58}Co$ reactions using particle beams from a tandem Van de Graaff, and analyzing reaction products in the Enge split pole spectrograph. Angular distributions at bombarding energies of 17 and 18 MeV respectively for the (d,α) and $(^3He,d)$ reactions were analyzed with the distorted wave Born approximation (DWBA) to determine orbital angular momentum transfers. Accurate ($\pm$0.3%) excitation energies were obtained for about 80 ^{56}Co levels and 120 ^{58}Co levels. Spectroscopic factors were obtained for 70 ^{57}Fe $(^3He,d)$ transitions. Two groups of l = 3 transitions separated by 700 keV were seen in $(^3He,d)$. $(p,^3He)$ and $(^3He,t)$ results of other investigators were used along with present data to suggest J^π assignments or narrow J^π limits for 46 ^{58}Co states. It was found particularly useful to investigate the $\sigma(d,\alpha)/\sigma(p,^3He)$ ratio for each L transfer. As expected on theoretical grounds cross sections for J^+ (odd) levels showed large and nearly constant ratios. Ratios for transition strengths to known J^+ (even) states were significantly smaller and vanished for $T_>$ states. The properties of 15 low-lying ^{56}Co levels could be correlated with those of states predicted in recent extended shell-model calculations of J. McGrory. The importance of two particle-two hole configurations in most of these states was demonstrated. Remaining discrepancies might be explained by a sizeable four hole-two particle strength in $^{58}Ni(g.s.)$. J^π assignments or suggestions were given for 88 ^{58}Co levels (including some of negative parity). It was found that some low-lying ^{58}Co levels can be described as $^{56*}Co$ plus a "spectator" neutron pair. Comparison with shell model calculations of McGrory for ^{58}Co gave indications that noticeable $(\pi f_{7/2}^{-1}, \nu f_{7/2}^{-1})$ strength appears first in the ^{58}Co spectrum for 4^+ states at around 500 keV of excitation. About 11 ^{58}Co states predicted by McGrory could be identified with those seen experimentally. (Diss. Abstr. Int., B)

21710 ISOBARIC ANALOG STATES IN THE $^{56}Fe(p,\gamma)^{57}Co$ REACTION. Waymire, David Russel. Provo, Utah; Brigham Young Univ. (1971). 117p. University Microfilms Order No. 72-1774. Thesis.

Resonance states in ^{57}Co at 7250 keV, 7265 keV, 7270 keV, 7355 keV, 7645 keV, and 7680 keV were investigated to determine if they were isobaric analogs to low lying nuclear states in ^{57}Fe. These resonances created at proton energies of 1250 keV, 1265 keV, 1270 keV, 1355 keV, 1650 keV, and 1685 keV were assigned spins and parities of $1/_2$-, $5/_2$-, $3/_2$-, $7/_2$-, $5/_2$-, and $1/_2$- respectively. From these spin and parity assignments and from relative separation energies, obtained from an excitation function, it was concluded that the 7250 keV $(1/_2$-) state is the analog to the $1/_2$- ground state in ^{57}Fe. Either the 7265 keV $(5/_2$-) or the 7270 keV $(3/_2$-) state is the analog to the 14 keV $(3/_2$-) state in ^{57}Fe. Whereas the 7645 keV $(3/_2$-) state is probably the analog to the 366 keV $(3/_2$-) level, the 7355 keV $(3/_2$-) and 7680 keV $(1/_2$-) states do not have the correct spins to be analogs to the 137 keV $(5/_2$-) and 366 keV $(3/_2$-) levels respectively. (Diss. Abstr. Int., B)

21711 ORIENTATION OF THE RESIDUAL NUCLEUS OF THE REACTION $^{56}Fe(d,p)^{57}Fe^*(14\ keV)^{57}Fe$. Appel, H.; Bueche, G.; Renz, W. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 501-6 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A study was made of the nuclear polarization in the $^{56}Fe(d,p)^{57}Fe$ reaction using 5.5-MeV deuterons. The magnetic hyperfine field was oriented perpendicular to the reaction plane and parallel to the possible nuclear vector polarization. The direction of observation of the 14-keV γ quanta was 27°, and the quanta were detected with a moving detector. In coincidence with the Moessbauer spectrum, protons were measured under two different angles (Θ_p) simultaneously, and the $3/_2^-$ (14 keV) and $3/_2^-$ (367 keV) proton groups were observed together. The relative difference in counting rates was found to be $-17 \pm 12\%$ and $+4 \pm 17\%$ for 26° and 35° Θ_p. The exact meaning of the results is discussed. (D.L.C.)

21712 MAGNETIC MOMENT DETERMINATION BY LINE-SHAPE ANALYSIS IN THE RECOIL-INTO-GAS METHOD. Bond, P. D.; Sprouse, G. D.; Miller, T. R.; Hanna, S. S. (Stanford Univ., Calif.). pp 981-4 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The use of the gamma-ray doublet to determine the perturbation produced by the hyperfine field was tested on the 0.847-MeV 2^+ state of ^{56}Fe excited by a ^{35}Cl beam. Spectra were collected for recoils into argon and vacuum. Two perturbation vs pressure curves

were drawn, using the W(90°)/W(0°) and the valley-peak ratio of the doublet; the line-shape method is seen to give increased sensitivity. (D.L.C.)

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Refer also to abstracts 20424, 21649, 21670, 21695, 21698, 21705, 21706, 21739, 21748, 21760, 21761, 21768, 21788, 21838, and 21841.

21713 (COO–1779-55) NUCLEAR SPECTROSCOPIC STUDIES OF SOME SHORT-LIVED AND NEUTRON DEFICIENT Ga AND Zn ISOTOPES. Giesler, Gregg Carl (Michigan State Univ., East Lansing. Dept. of Chemistry). 1971. 201p. Dep. NTIS. Thesis.

The decay schemes of ^{63}Zn, ^{62}Zn and ^{63}Ga were investigated by high-resolution γ-ray spectroscopy in an effort to further elucidate their nuclear properties. Also, a search for β-delayed α emission from the light Ga isotopes was conducted. Such γ-ray spectroscopic techniques as Ge(Li) singles, Ge(Li)–Ge(Li) megachannel coincidence, Ge(Li)–NaI(Tl) coincidence, and Ge(Li)-time coincidence techniques were utilized to study these isotopes. A He-jet thermalizer was utilized in the search for β-delayed α emission. Several programs written for data analysis are presented. Forty-five γ rays were assigned to the decay of 38.4-minute ^{63}Zn and were incorporated into a decay scheme containing 24 levels with energies of 0, 669.71, 962.14, 1327.0, 1412.07, 1546.8, 1860.9, 1865.7, 2012.0, 2062.3, 2081.4, 2093.5, 2336.8, 2497.5, 2512.5, 2536.2, 2697.0, 2717.2, 2780.1, 2857.8, 2889.5, 3044.0, and 3100.3 keV. A search for γ rays with energies above 700 keV from the decay of 9.3-hour ^{62}Zn was conducted and six were found at energies of 881.4, 915.6, 1142.5, 1280.8, 1389.1, and 1429.9 keV. They were placed in a decay scheme containing seventeen γ-rays and ten levels with energies of 0, 40.94, 243.44, 287.98, 548.41, 637.53, 915.6, 1142.5, 1280.8, and 1429.9 keV. The decay of 32.4-second ^{63}Ga has sixteen γ rays which were placed in a decay scheme containing nine levels with energies of 0, 193.0, 248.0, 627.1, 637.0, 650.1, 1065.2, 1395.4, and 1691.7 keV. Spin and parity assignments for the nuclear states investigated are based on log ft values, relative γ-ray intensities to states of known spin and parity and charged particle scattering results. A survey of and comparison with previously reported Ge(Li) detector results and with charged particle scattering results is presented for these isotopes. The structures of the low-lying states in these nuclei are discussed and compared with theoretical calculations and systematics of the region. A search for β-delayed α emission from the short-lived (<5 sec) Ga isotopes through ^{60}Ga was conducted. The γ-ray and α-particle spectra from the nuclei produced are presented. An upper limit of ten parts per million was placed on β-delayed α branching from the decay of these nuclei. (auth)

21714 (FEI–244) DIFFERENTIAL SCATTERING CROSS SECTIONS OF NEUTRONS FOR SMALL ANGLES AND POLARIZABILITY OF THE NEUTRON. Anikin, G. V.; Kotukhov, I. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

A more complete publication of the measurement results for neutron scattering cross sections in the angular range of 2.5 to 24°, the preliminary information for which is given in a previous paper (G. V. Anikin, Y. A. Alexander, and A. S. Soldatov, Intern. Conf. on the Study of Nuclear Structure with Neutrons, Antwerp, Belgium, July 19 to 23, 1965) is presented. The differential cross sections (relative units) for three elements are given: uranium, lead, and copper. Comparison of the experimental angular distributions with those computed in the framework of the optical model shows that their compatibility can be substantially improved by introducing a small correction to the nuclear potential, corresponding to the polarizability of the neutron, of the order of 2.10^{-40} cm^3. (JPRS)

21715 (HEDL-TME-71-143) CROSS SECTION EVALUATIONS OF TWENTY-SEVEN FISSION PRODUCT ISOTOPES FOR ENDF/B-III, MAT 1201–1231. Schenter, R. E.; Schmittroth, F. A. (Hanford Engineering Development Lab., Richland, Wash.). Oct 1971. Contract AT(45-1)-2170. 129p. (ENDF-159). Dep. NTIS.

Microscopic cross section evaluations of twenty-seven fission product isotopes which are important for reactor analyses are described. These evaluations are to be incorporated as data files for ENDF/B-III. Emphasis was placed upon obtaining accuracy in the capture cross section data. Theoretical values of the capture cross sections were obtained using the Hauser–Feshbach (with width fluctuation corrections) formalism. (auth)

21716 (NP–19042) ANALYSIS OF ^{63,65}Cu(^{3}He,d)^{64,66}Zn REACTION IN THE UNIFIED MODEL. Abecasis, S. M.; Krmpotic, F.; Plastino, A. (Buenos Aires Univ. (Argentina). Departamento de Fisica. Instituto de Investigaciones Aeronauticas y Espaciales, Buenos Aires (Argentina). Laboratorio de Radiaciones). Dec 1970. 10p. (LR–29). Dep. NTIS (U. S. Sales Only).

An analysis of the experimental spectroscopic factors involved in the ^{63,65}Cu (He,d) ^{64,66}Zn reactions is proposed within the intermediate coupling approach in the unified model. (auth)

21717 (NP–19044) K X-RAY-γ-DIRECTIONAL CORRELATIONS IN THE DECAY OF ^{54}Mn, ^{65}Zn, ^{75}Se, ^{85}Sr, ^{133}Ba, AND ^{207}Bi. Bosch, H. E.; Farioli, M. A.; Behar, M.; Bermudez, G. Garcia (Buenos Aires Univ. (Argentina). Departamento de Fisica. Instituto de Investigaciones Aeronauticas y Espaciales, Buenos Aires (Argentina). Laboratorio de Radiaciones). Dec 1970. 11p. (LR–32). Dep. NTIS (U. S. Sales Only).

K X-ray-γ-directional correlations following the decay of ^{54}Mn, ^{65}Zn, ^{75}Se, ^{85}Sr, ^{133}Ba and ^{207}Bi were performed. The experimental set-up consisted of a set of four scintillation counters. One for detecting X rays and the three others for detecting gamma rays, placed at 90, 180 and 270° with respect to the source-to-X-ray detector direction. Multiple coincidence units and a logic system were used in order to display three X-ray spectra in three 128-channel submemories of a 512-channel analyzer, corresponding to coincidences between X rays and gamma rays detected in each counter, respectively. For the case of the ^{133}Ba X–γ angular correlation, the scintillation counters were replaced by one Ge(Li) detector in order to select with high resolution the gamma ray of 356 keV. Corrections for chance coincidences were made and a χ^2-test of the data was performed. From the K X-γ-directional correlations following the above mentioned decays a value of the anisotropy was derived. In all cases this value is consistent with zero, within one percent error. These results are in agreement with the theoretical predictions of Dolginov. A discrepancy with the anisotropy value reported by Perepelkin appeared. The values corresponding to the decays of ^{65}Zn and ^{85}Sr and ^{133}Ba are consistent with the ones reported by Ramaswamy and McDonnell and Ramaswamy. (auth)

21718 LEVELS OF ^{59}Ni POPULATED IN THE REACTION ^{59}Co(p,nγ)^{59}Ni. Kraft, O. E.; Naumov, Yu. V.; Orlov, B. N.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 4, 678–86(Apr 1971). (In Russian).

The gamma spectrum arising from the reaction ^{59}Co(p,nγ)^{59}Ni was determined to study the population characteristics of low-lying ^{59}Ni levels. A beam of 6-MeV protons was generated in a cyclotron and used to bombard a thin foil of ^{59}Co. From an analysis of the γ spectrum, the de-excitation scheme of ^{59}Ni was derived. The levels at 1.301, 1.190, 1.340, and 1.949 MeV in particular are discussed. (K.S.W.)

21719 CAPTURE CROSS SECTION OF 14-MeV NEUTRONS. Majumder, Manjushree (Bose Inst., Calcutta). Indian J. Phys.; 44: No. 3, 204-11(Mar 1970).

Radiative capture cross sections for some nuclei round about mass number 100 have been measured for 14.3 MeV neutrons by the activation technique. Sources of systematic errors and the steps taken to control them have been discussed. The results have been compared with those given by Perkin et al and Csikai et al. Data obtained are very much different from those predicted by the compound nucleus theory. (auth)

21720 GAMMA-RAY EMISSION IN COMPETITION WITH NEUTRON EMISSION IN THE BETA DECAY OF ^{87}Br. Slaughter, D. R.; Nuh, F. M.; Shihab-Eldin, A. A.; Prussin, S. G. (Univ. of California, Berkeley). Phys. Lett.; 38B: No. 1, 22-4 (10 Jan 1972).

Evidence is presented for the existence of a γ ray at 5594.7 ± 0.6 keV following beta decay of ^{87}Br. This observation indicates population of neutron unbound levels in ^{87}Kr from which photon emission competes successfully with neutron emission. (auth)

21721 ANGULAR DISTRIBUTION MEASUREMENTS IN THE (γ,γ') REACTION ON VARIOUS ISOTOPES. Moreh, R.; Nof, A.; Shahal, O. (Nuclear Research Centre-Negev, Beer Sheva, Israel). pp 235-8 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Some energy levels in ^{74}Ge and ^{139}La were excited by photon resonance scattering using capture γ rays from iron and titanium. The scattered γ spectra and angular distributions were measured using a Ge(Li) detector. Some spin-parity assignments and multi-

pole mixing ratios for levels in ^{74}Ge and ^{174}La were deduced. (J.W.R.)

21722 K X-RAY γ-DIRECTIONAL CORRELATIONS IN THE DECAY OF ^{51}Mn, ^{65}Zn, ^{75}Se AND ^{85}Sr. Bosch, H. E.; Fariolli, M. A.; Behar, M.; Bermudez, G. Garcia (Univ., Buenos Aires). pp 267-70 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Directional correlations between K x-rays and γ rays for electron capture from the k-sheil in ^{54}Mn, ^{65}Zn, ^{75}Se, and ^{85}Sr were measured using a conventional fast-slow coincidence system with scintillation detectors. No evidence for even small anisotropies was found. The results were compared with previous data. (J.W.R.)

21723 BETA MATRIX ELEMENTS FOR SOME FIRST FORBIDDEN DECAYS FROM ANGULAR CORRELATIONS. Manthuruthil, J. C.; Poirier, C. P. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). pp 311-15 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Beta-gamma angular correlations vere measured in the decays of $^{84-86}$Rb, ^{124}Sb, ^{152}Eu, and ^{186,188}Re. The results were used to extract matrix elements for first-forbidden transitions. (J.W.R.)

21724 MAGNETIC MOMENTS FOR THE 265 keV AND 280 keV LEVELS IN ^{75}As. Becker, A. J.; Zawislak, F. C. (California Inst. of Tech., Pasadena). pp 543-6 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Time-integral perturbed angular correlations of γ rays following the decay of ^{75}Se in a polarized Fe lattice were measured. The results were used to determine magnetic moments for the 265- and 280-keV levels in ^{75}As. These moments are interpreted using a deformed nucleus model. (J.W.R.)

21725 MAGNETIC MOMENTS AND LIFETIMES OF A (3^+) 273 keV LEVEL IN ^{74}As AND THE 1^+ 45 keV LEVEL IN ^{76}As. Becker, M.; Bertschat, H.; Mahnke, H.-E.; (and others) (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 564-8 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Energy levels in ^{74}As and ^{76}As were populated by the ^{74}Ge and ^{76}Ge(p,n) reactions, respectively. A pulsed proton beam with a width of 10 ns and a repetition rate of 1 μs was used. Gyromagnetic ratios for the 273-keV level in ^{74}As and the 45-keV level in ^{76}As were determined by stroboscopic observation of the nuclear Larmor precession. Lifetimes for these states were determined from the delayed time spectra. (J.W.R.)

21726 PERTURBED ANGULAR CORRELATIONS FOR THE (596-42) keV CASCADE IN ^{62}Cu. Bozek, E.; Golczewski, J.; Hrynkiewicz, A. Z.; (and others) (Inst. of Nuclear Physics, Krakow). pp 571-5 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Directional correlations for the 596-42 keV γ−γ cascade following the decay of ^{62}Zn were measured. The perturbation of the angular correlation was measured with liquid sources in an external magnetic field and with metallic sources in a ferromagnetic Ni lattice. A mean value of g = 0.67 ± 06 was determined for the g-factor of the 42-keV state in ^{62}Cu. (J.W.R.)

21727 PHOTONEUTRON CROSS SECTION IN ^{63}Cu AND ^{141}Pr. Dreyer, F.; Dahmen, H.; Staude, J.; Thies, H. H. (Univ., Heidelberg). Nucl. Phys.; A181: No. 2, 477-88(1972).

The (γ,n) cross section in ^{63}Cu and ^{141}Pr was measured from threshold to 33 MeV by using bremsstrahlung from a betatron and observing the induced ^{62}Cu and ^{140}Pr activities. Under adequately high resolution both cross sections show structure which is well described by the collective theory of Huber and Greiner. (auth)

21728 PREDICTED REGION OF OBLATE DEFORMATION AROUND ^{72}Kr. Dickmann, F. (Kernforschungszentrum, Karlsruhe, Ger.); Metag, V.; Repnow, R. Phys. Lett.; 38B: No. 4, 207-10(21 Feb 1972).

Strutinsky-type calculations of the potential energy predict oblate ground state deformations for nuclei around ^{72}Kr. (auth)

21729 LEVELS EXCITED IN THE ^{70}Ge(p,d)^{69}Ge AND ^{70}Ge (p,t)^{68}Ge REACTIONS. Hsu, T. H. (Univ. Of Ottawa); Fournier, R.; Hird, B.; (and others). Nucl. Phys.; A179: No. 1, 80-8(1972).

Measurements of the reaction ^{70}Ge(p,d)^{69}Ge with 20 MeV protons on an enriched target have established 18 new levels in ^{69}Ge. The angular distributions were fitted using the DWBA, and the spectroscopic factors for the transitions to many of these levels were obtained. From the pick-up sum rules the filling of the $2p_{\frac{3}{2}}$, $1f_{\frac{5}{2}}$, $2p_{\frac{1}{2}}$ and $1g_{\frac{9}{2}}$ neutron subshells in ^{70}Ge were found to be 60−80%, 80−85%, 30−60%, and 10−13%, respectively. Six excited levels were observed in the ^{70}Ge(p,t)^{68}Ge reaction, including two previously identified levels. In contrast to the other even germanium isotopes, no 0^+ excited state was seen below 3 MeV. The mass excess of ^{68}Ge was found to be −66.969 ± 0.013 MeV, in good agreement with theoretical predictions. (auth)

21730 DECAY OF ^{78}Sr. Bilge, A. N.; Boswell, G. G. J. (Univ. of Salford, Eng.). J. Inorg. Nucl. Chem.; 33: No. 12, 4001-4(Dec 1971).

^{78}Sr was produced by the ^{64}Zn(^{16}O,2n)^{78}Sr reaction using 160-MeV oxygen ions bombarding natural zinc foil. The half-life of ^{78}Sr is 30.6 ± 2.3 m. The mass assignment is confined by measurements of the growth and decay of the γ-radiations at 455, 664 and 1109 keV in the ^{78}Rb daughter. (auth)

21731 STANDARDIZATION OF ^{63}Ni BY EFFICIENCY TRACING. Baerg, A. P.; Bowes, G. C. (National Research Council, Ottawa). Int. J. Appl. Radiat. Isotop.; 22: No. 12, 781-3(Dec 1971).

The possibility of calibrating ^{63}Ni by the efficiency tracing method was examined and the activity content of a solution standard, prepared by the National Bureau of Standards, was measured by this method. The result of 1.50×10^6 sec^{-1} g^{-1} (±1.1%) is in satisfactory agreement with those obtained at the NBS and the CRNL (ibid 777-81, 783-85). (auth)

21732 COMPLETE FUSION INDUCED BY KRYPTON IONS: INDICATIONS FOR SYNTHESIS OF SUPERHEAVY NUCLEI. Bimbot, R. (Institut de Physique Nucleaire, Orsay, France); Tamain, B. Nature (London); 234: No. 5326, 215-16(26 Nov 1971).

It is stated that complete nuclear fusion was produced by bombarding targets of Ge, Cd and Th with 450 MeV Kr^{23+} and 500 MeV Kr^{24+} ions obtained from the Orsay accelerator ALICE. Typical bombardment times were of the order of 10 hr, with 10^6 Kr ions/sec. Recoiling synthesized nuclei were slowed down, transferred through a capillary tube, and deposited on a steel rod in an evacuated chamber. An annular Si semiconductor counter around the capillary tube detected the α-particles produced by the decaying nuclei. The α-spectrum obtained by bombarding a Th target with 500 MeV Kr^{24+} ions is shown. The most significant result was the observation of pulses corresponding to α-energies >9 MeV that had not been found at 450 MeV bombardment, probably because the energy was near the Coulomb barrier. It was concluded that because of the conditions under which the α-particles were produced they might have come from superheavy nuclides for which theory predicts α-disintegrations of 13 to 14 MeV, with half-lives of ms. (UK)

21733 ^{63}Ni: STANDARDIZATION, HALF-LIFE, AND NEUTRON-CAPTURE CROSS-SECTION. Barnes, I. L.; Garfinkel, S. B.; Mann, W. B. (National Bureau of Standards, Washington, D. C.). Int. J. Appl. Radiat. Isotop.; 22: No. 12, 777-81(Dec 1971).

Nickel-63 was standardized for activity using the National Bureau of Standard's radiation balance and a calculated value for the average β-particle energy. From the activity and isotopic abundance of ^{63}Ni in May 1968, the half-life was calculated to be 100.0_7 yr (±2.0%). The neutron-capture cross-section was found to be 23 ± 3 barn. (auth) (UK)

21734 STANDARDIZATION OF ^{63}Ni AND THE DECAY OF ^{65}Ni. Merritt, J. S.; Taylor, J. G. V. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Int. J. Appl. Radiat. Isotop.; 22: No. 12, 783-5(Dec 1971).

The activity concentration of a standardized ^{63}Ni solution distributed by the National Bureau of Standards was determined by 4π β−γ efficiency tracing to be $1.523 \pm 0.017 \times 10^6$ sec^{-1} g^{-1} corrected to May 1968. This is consistent with values obtained at the NBS and the National Research Council of Canada (ibid 777-81, 781-3). A half-life of 2.520 ± 0.002 hr was measured for ^{65}Ni;

it was found that the 1482 keV γ-ray is emitted in (23.5 ± 0.8)% of ^{65}Ni decays. (auth) (UK)

21735 DECAY OF ^{68}Ga. Dulfer, G. H.; Ketel, T. J.; van Rooijen, V. A.; Wigmans, M. E. J.; Verheul, H. (Vrije Univ., Amsterdam). Nucl. Phys.; A182: No. 2, 433-42(1972).

Ge(Li) γ-ray singles measurements and a NaI(Tl)–Ge(Li) coincidence experiment were performed in a reinvestigation of the decay of 15-min ^{65}Ga. Eighty-nine γ rays were attributed to this decay. In the proposed decay scheme 32 of these γ rays (representing about 99.5% of the total intensity of the γ rays) were placed. The intensity of the annihilation radiation was determined using also a mass-separated source. (auth)

21736 STUDY OF THE ENERGY LEVELS OF ^{75}Se. Coban, A.; Willmott, J. C.; Lisle, J. C.; Murray, G. (Univ. of Manchester, Eng.). Nucl. Phys.; A182: No. 2, 385-99(1972).

A level scheme was established for ^{75}Se by observing the γ rays and conversion electrons following the decay of ^{75}Br, and spins and parities were assigned to some of the states. A search was made for a low-lying $\frac{1}{2}^-$ state that systematically occurs in odd-A nuclei with N between 39 and 47, but no candidate was found. It was demonstrated that a doublet occurs at 286.5 keV, and that the two components probably possess $J^\pi = \frac{3}{2}^-$ and $\frac{5}{2}^-$. (auth)

21737 LEVELS OF ^{88}Zr OBSERVED IN THE DECAY OF ^{88g}Nb AND ^{88m}Nb. Iafigliola, R.; Turcotte, R.; Moore, R. B.; Lee, J. K. P. (McGill Univ., Montreal). Nucl. Phys.; A182: No. 2, 400-10(1972).

The level structure of ^{88}Zr was studied by the observation of the γ rays following the decay of ^{88g}Nb and ^{88m}Nb by using Ge(Li) detectors. The half-lives of ^{88g}Nb and ^{88m}Nb were measured to be 14.3 ± 0.3 min and 7.8 ± 0.2 min, respectively. A Ge(Li)–Ge(Li) coincidence experiment was also performed, and the decay schemes with spin and parity assignments for levels in ^{88}Zr are proposed. (auth)

21738 STUDIES ON SOME $2^- \rightarrow 2^+$ BETA TRANSITIONS. Khayyoom, A.; Narasimha Raju, M. L.; Sastry, D. L. (Andhra Univ., Waltair, India). Nuovo Cim.; 7A: No. 3, 695-703(1 Feb 1972).

Beta–gamma directional correlations of the 587-keV beta transition in ^{142}Pr and the 1200-keV beta transition in ^{76}As were studied with a conventional fast–slow coincidence scintillation assembly. In the decay of ^{142}Pr the correlation coefficient is small and independent of the beta energy. In the decay of ^{76}As the correlation coefficient varies from 2% to 5% in the beta-energy range 600 to 1200 keV. The reduced beta coefficient of this beta transition, $R(W)_{1200}$, is found to differ significantly from the reduced beta coefficients of the 2410-keV and the 1750-keV beta transitions in the decay of ^{76}As. The results seem to support a quasi-particle description of the 2^+ excited states in ^{76}Se. (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 20771, 21302, 21339, 21649, 21695, 21715, 21719, 21721, 21723, 21727, 21732, 21738, 21789, 21841, 21886, 22159, and 22161.

21739 (COO-1779-71) ANNUAL REPORT FOR THE PERIOD JULY 1, 1970–JULY 1, 1971. (Michigan State Univ., East Lansing. Cyclotron Lab.). Sep 1971. Contract AT(11-1)-1779. 306p. Dep. NTIS.

A series of brief writeups on research in progress, abstracts of talks at meetings, and reprints of published papers are presented. Also, sources of financial support for MSU Cyclotron Laboratory programs, faculty and postdoctoral personnel, and Ph. D. thesis titles are listed. (W.H.K.)

21740 (IS-T-472) GAMMA-RAY DECAY SCHEMES FOR ^{92}Kr, ^{92}Rb, AND ^{92}Sr. Olson, Richard John (Ames Lab., Iowa). Nov 1971. Contract W-7405-eng-82. 176p. Dep. NTIS. Thesis.

Measurements made with Ge(Li) detectors are reported for gamma-ray energies and intensities present following the beta decay of the neutron-rich nuclei ^{92}Kr, ^{92}Rb, and ^{92}Sr. These nuclides are members of the mass chain A = 92 beginning with ^{92}Kr, which was obtained using the on-line isotope separator system TRISTAN developed for the study of gaseous fission products. Level schemes were constructed for ^{92}Rb, ^{92}Sr, and ^{92}Y with the aid of Ge(Li)–Ge(Li) coincidence results. An attempt is made to interpret some of the energy levels found from the shell-model basis. (auth)

21741 (JINR-P6-6167) STRUCTURE OF THE $^{148\ 150\ 152}$Tb ISOMERIC STATES AND OF THE $^{148\ 150\ 152}$Gd AND $^{146\ 148}$Sm TWO-PARTICLE LEVELS. Arl't, R.; Kuznetsov, V. V.; Nolbert, V.; Peker, L. K.; Potempa, A. V.; Hagemann, U. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

Possible spins of ^{148}Tb and ^{150}Tb isomers are discussed, and a comparison with the neighboring nuclei ^{146}Eu, ^{148}Eu and ^{154}Ho is made. The decay schemes of ^{148m}Tb and ^{150m}Tb are discussed. A conclusion on the level spin of two-particle nature of ^{148}Gd and ^{150}Gd is drawn. The Mayer scheme describes well the nature of the excited states of these nuclei. (auth)

21742 EXCITATION OF THE QUADRUPOLE STATE OF ^{106}Pd DURING INELASTIC SCATTERING OF α-PARTICLES. Gonchar, V. Yu.; Yushkov, A. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 4, 836-7(Apr 1971). (In Russian).

The correctness of a proposed superfluid model in connection with inelastic scattering of α particles was tested experimentally in a cyclotron by the excitation of the quadrupole state of the ^{106}Pd nucleus with 38-MeV α particles. The results agreed satisfactorily with those predicted by theory. (K.S.W.)

21743 EXCITED STATE ^{147}Gd, PRODUCED BY THE DECAY OF ^{147}Tb. Afanas'ev, V. P.; Gromova, I. I.; Iskhakov, G.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 4, 719-24(Apr 1971). (In Russian).

The isotope ^{147}Tb was obtained from the disintegration of the Tb nucleus after irradiation with 660-MeV protons in a synchrocyclotron. The half-life of ^{147}Tb was determined to be 1.7 ± 0.1 hr, and the decay scheme associated with the reaction ^{147}Tb → ^{147}Gd is given. (K.S.W.)

21744 $M_I : M_{II+III} : M_{IV+V}$ RATIOS FOR THE PURE M4 TRANSITIONS IN THE ^{125}Te AND ^{127}Te NUCLEI. Kalinauskas, R. A.; Makaryunas, K. V.; Davidonis, R. I. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys; 11: No. 1, 145-52(1971). (In Russian).

The internal conversion in the M-subshells for the M4 pure multipolarity transitions in the ^{125}Te (109.27 keV) and ^{127}Te (89 keV) nuclei has been investigated by a prismatic β-spectrometer UMB-1 at the resolution Δp/p = 0.04 – 0.05%. The experimental results are compared with the theoretical ones of Rose, corrected by the method of Chu and Perlman. (auth)

21745 LEVELS AND TRANSITIONS IN ^{104}Pd FROM THE DECAY OF ^{104m}Rh AND ^{104g}Rh. Okano, K.; Kawase, Y.; Uehara, S. (Kyoto Univ., Osaka). Nucl. Phys.; A182: No. 1, 131-44(1972).

Singles and coincidence spectra of γ-rays following the decay of 4.41 min ^{104m}Rh and 43 sec ^{104g}Rh have been studied using Ge(Li) and NaI(Tl) detectors. The γ-rays of 17 transitions in the decay of ^{104m}Rh and of 8 transitions in the decay of ^{104g}Rh have been observed and their energies and relative intensities have been determined. The negaton decay of the 5^+ isomeric state has been found to lead to the levels in ^{104}Pd at 1323.5 ± 0.7(4^+), 2082.3 ± 0.6(4^+), 2181.5 ± 0.6(4^+) and 2265.4 ± 0.6 keV (4^+), while the 1^+ ground state has been found to decay to the levels as 555.7 ± 0.5(2^+), 1333.6 ± 1.0(0^+), 1341.5 ± 0.4(2^+), 1792.7 ± 0.6(0^+) and 1793.2 ± 1.2 keV in addition to the ground state. Gamma-gamma angular correlations have been measured on 6 cascading transitions in ^{104}Pd using the NaI(Tl)-Ge(Li) coincidence spectrometer and an automatic irradiation apparatus. The spin of the 1333.6 and 1792.7 keV levels has been uniquely determined as 0. The multipolarity of the 785.6 keV $2'^+ \rightarrow 2^+$ transition has been determined to be E2 + <1% M1, as is consistent with the vibrational model description. The M1–E2 mixing ratios of the transitions from the 4^+ states at three-phonon region to the two-phonon 4^+ state have been determined. The level structure and transitions in ^{104}Pd are discussed in the light of the vibrational model. The systematic trend of log ft values to the phonon states in Pd isotopes is discussed. It is found that the allowed β-transitions from the 1^+ states to the two-phonon 0^+ and 2^+ states are generally hindered compared with those to the zero- and one-phonon states, while the transitions to the 2^+ states at three-phonon region are less hindered compared with those to the two-phonon 2^+ states. (auth)

21746 LIFETIMES OF SOME EXCITED STATES IN ^{133}Cs. Badawy, O. E.; Awwad, Z.; El-Asser, M. R.; El-Farrash, A. H.; Migahed, M. (Atomic Energy Establishment, Cairo). Atomkernenergie; 19: No. 1, 58-62(Feb 1972).

The half-lives of the 81-keV and 161-keV excited levels of ^{133}Cs have been measured by means of a delayed coincidence technique. (auth)

21747 B(E2) FOR THE FIRST 2^+ STATE IN ^{90}Zr. Metzger, F. R. (Bartol Research Foundation, Swarthmore, Pa.). Nucl. Phys.; A182: No. 1, 213-18(1972).

A model-independent measurement of the width of the first 2^+ state (2.186 MeV) of ^{90}Zr has been carried out using the resonant scattering of bremsstrahlung and its detection with a Ge(Li) detector. The observed resonance fluorescence yield corresponds to a reduced E2 transition probability $B(E2\uparrow) = 608 \pm 35\ e^2 \cdot fm^4$. The difference between this value and recent inelastic electron scattering results exceeds the range usually attributed to the model dependence of the latter. (auth)

21748 ANGULAR CORRELATIONS IN NUCLEAR DISINTEGRATION. Proceedings of the International Conference, Delft, Netherlands, August 17–22, 1970. van Krugten, Hans; van Nooijen, Bob (eds.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971). 651p. Dfl. 70.00. (CONF-700807).

Separate abstracts were prepared for 72 of the 77 papers included. The remaining 5 papers have previously appeared in NSA. (J.W.R.)

For abstracts of individual papers see: 20392, 20421–20424, 20524, 21034, 21622, 21674–21677, 21700, 21721–21726, 21749–21758, 21798–21811, 21833–21837, 21862, 21863, and 21920–21941.

21749 NUCLEAR PENETRATION EFFECTS IN THE 92 keV TRANSITION IN ^{131}Cs. Hasselgren, L.; Antman, S.; Sahota, H. S.; Thun, J. E. (Univ. of Uppsala). pp 173–6 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Nuclear penetration effects in the 92-keV internally converted transition in ^{131}Cs were studied using an angular correlation method. Angular correlation coefficients for the 404-216 keV and 404-92 keV cascades were determined. The multipolarity and penetration parameter for the 92-keV transition were obtained (J.W.R.)

21750 REVIEW OF ALL QUADRUPOLE MOMENTS MEASURED BY COULOMB EXCITATION. Povh, B. (Univ., Heidelberg). pp 327–35 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The reorientation method of measuring static quadrupole moments following Coulomb excitation is described. Some of the difficulties associated with the method are discussed. The available data on quadrupole moments measured by the method are reviewed. (J.W.R.)

21751 RESULTS FROM OBSERVED RESONANCES IN PERTURBED ANGULAR CORRELATIONS DUE TO CROSSING HYPERFINE LEVELS. Leisi, H. J.; Ledebur, Th. v.; Gygax, F. N. (Swiss Federal Inst. of Tech., Zurich). pp 444–8 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Gamma-gamma perturbed angular correlations for the 172-203 keV cascade in ^{127}I and the 55-188 keV cascade in ^{125}I. Resonances due to crossing hyperfine levels were observed. Resonance widths were extracted with a view toward determining lifetimes for the nuclear states involved. Although complications arose in the present experiment, the results show that resonance experiments may possibly be used to measure short nuclear lifetimes. (J.W.R.)

21752 EFFECTS OF PAC ON HALF-LIFE MEASUREMENTS. Baeverstam, U.; Hoejeberg, M. (Univ. of Stockholm). pp 451–4 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

If the angular correlation for a nuclear cascade is perturbed, the decay curve is not a simple exponential. The consequences for half-life measurements using delayed coincidence techniques in the case of PAC are discussed. It is shown that such perturbations can give errors in the half-lives for certain cases as large as 20 to 30%. (J.W.R.)

21753 INTERDEPENDENCE OF MOESSBAUER EFFECT AND γ–γ ANGULAR CORRELATION IN ^{119m}Sn. Berger, H. L.; Medicus, H. A. (Rensselaer Polytechnic Inst., Troy, N. Y.). pp 510–13 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters–Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Gamma rays emitted by nuclei in regions of high crystal regularity in randomly oriented polycrystalline solids should experience smaller hyperfine fields than in regions where lattice structure is poor. The Moessbauer effect should be more probable in these regions of high crystal regularity. This relationship was studied for the recoilless emission in the 23.8-keV transition and the angular correlation of the 65-23.8 keV γ cascade in metallic ^{119}Sn. The results indicate that a correlation exists between recoilless emission and the lack of perturbation in the intermediate state. (J.W.R.)

21754 MAGNETIC MOMENT OF THE LOWEST 2^+ VIBRATIONAL STATE IN ^{102}Ru. Ahmed, M. R.; Johansson, K.; Karlsson, E.; Norlin, L.–O. (Univ. of Uppsala). pp 547–9 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Perturbed angular correlation techniques were used to measure the g-factor of the 475-keV 2^+ level in ^{102}Ru following the decay of ^{102}Rh. The result was compared with theoretical estimates and with previous experimental data. (J.W.R.)

21755 MAGNETIC MOMENT AND HALF-LIFE OF THE FIRST EXCITED STATE IN ^{134}Cs. Drost, H.; Weiss, W.; Weyer, G. (Freie Univ., Berlin). pp 549–52 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The g-factor of the first-excited 5^+ state in ^{134}Cs was measured using the time differential perturbed angular correlation method for a ^{134m}Cs source. A delayed coincidence setup was used to determine the half-life of the level. (J.W.R.)

21756 MAGNETIC MOMENT OF THE $(g_9^2)8^+$ STATE IN ^{90}Zr. Katou, T. (Inst. of Physical and Chemical Research, Yamatomachi, Japan); Nagamiya, S.; Nomura, T.; Yamazaki, T. pp 561–3 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters–Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

A pulsed-beam spin-precision experiment on the ^{88}Sr(α,2n) reaction was performed to determine the g-factor of the 8^+ 3592-keV state in ^{90}Zr. A g-factor of 1.364 ± 0.015 was obtained. Implications concerning the magnetic core polarization are discussed. (J.W.R.)

21757 SPECTROSCOPIC STUDY OF ^{125}Te. Rots, M.; Silverans, R.; Coussement, R. (Univ., Louvain, Belg.). pp 575–6 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Perturbed γ–γ angular correlations following the decay of ^{125}Sb were measured for an Sb source in an iron and nickel matrix using Ge(Li) and NaI(Tl) detectors in a fast-slow coincidence setup. Multipolarities for a number of transitions in ^{125}Te were determined and the magnetic moments for the 320- and 463-keV states were deduced. A spin of $\frac{1}{2}^-$ was assigned to the 525-keV state. (J.W.R.)

21758 QUADRUPOLE MOMENT OF ^{133}La AND SHAPE ISOMERISM. Valentin, L.; Gerschel, C.; Perrin, N. (IPN, Orsay, France). pp 604–6 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The quadrupole moment of the $3/2^-$ level at 535.4 keV in ^{133}La was determined from differential perturbed angular correlations following the decay of ^{133}Ce embedded in polycrystalline lanthanum–magnesium–dinitrate. The large deformation implied from the quadrupole moment is consistent with the hypothesis of shape isomerism. The magnetic moment for the state also supports this interpretation. (J.W.R.)

21759 HIGH-SPIN LEVELS IN ^{96}Mo AND ^{97}Mo FROM (α,xn) REACTIONS. Mesko, L. (Research Inst. for Physics, Stockholm); Nilsson, A.; Hjorth, S. A.; Brenner, M.; Holmlund, O. Nucl. Phys.; A181: No. 2, 566–88(1972).

New energy levels with spin values up to at least $^{19}/_2$ in ^{95}Mo and $^{13}/_2$ in ^{97}Mo are inferred from the γ radiation which is emitted when a ^{94}Zr target is bombarded with α particles of various energies between 12 and 43 MeV. The proposed level schemes are supported in part by coincidence measurements; and spin–parity assignments are based upon the observed excitation functions, angular distributions, and polarizations of the emitted γ rays. (auth)

21760 INELASTIC SCATTERING OF 61 MeV PROTONS FROM ^{90}Zr AND ^{89}Y. Whiten, M. L. (Univ. of Georgia, Athens); Scott, Alan; Satchler, G. R. Nucl. Phys.; A181: No. 2, 417-39 (1972).

Differential cross sections for the excitation by 61.2-MeV protons of the first seven resolved states in ^{90}Zr were measured over the angular range 18 to 105°. The results are analyzed using a microscopic model including knock-on exchange and core polarization, with central interactions of Yukawa and Hamada–Johnston type. The analogous excitations of the 5^- state in ^{90}Zr and the $^9/_2^+$ state in ^{89}Y are compared; it is shown that core polarization of the E5 type is more important for the former, but there may be additional core polarization of M4 type in the latter transition. It is also shown that unnatural-parity exchange may be important for the excitation of the $(g_{9/2})^2$ sequence of states in ^{90}Zr. Both microscopic and collective models were used for the 3^- state in ^{90}Zr. (auth)

21761 GAMMA DECAY IN ^{90}Y. Lins, W. (Univ., Bonn); Ernst, J.; Takahashi, Kn.; Grosse, E.; Proetel, D. Nucl. Phys.; A179: No. 1, 161-76(1972).

The γ-decay of levels up to 3.2 MeV excitation energy in ^{90}Y has been observed in coincidence with protons from the reaction ^{89}Y(d,p)^{90}Y at E_d = 6 MeV. In addition, the γ-ray spectra from the reaction ^{87}Rb(α,nγ)^{90}Y have been measured at E_α = 10 to 14 MeV. The γ-decays are discussed in terms of transitions between proton–neutron states. Levels found at 953, 1047, 1189 and 1298 keV are considered to be members of the $(g_{9/2}\pi)(d_{5/2}\nu)$ sextet and are tentatively assigned J^π values of 3^+, 5^+, 4^+ and 6^+, respectively. This is supported by branching ratios and by excitation functions in the (α,nγ) measurement. The level order of the sextet agrees with that in ^{92}Nb and with recent model calculations. (auth)

21762 QUASI-ROTATIONAL GROUND-STATE BANDS OF EVEN–EVEN NUCLEI WITH $50 \leq N,Z \leq 82$. Habs, D. (Univ., Heidelberg); Klewe-Nebenius, H.; Loehken, R.; (and others). Z. Phys.; 250: No. 2, 179-90(1972).

The quasirotational ground-state bands of ^{140}Sm, ^{142}Sm, ^{144}Gd, and ^{136}Nd have been determined by studying the prompt γ decay after (α,xn + yp + zα) reactions using α particles of up to 104 MeV and targets of ^{144}Sm, ^{142}Nd, ^{141}Pr, ^{140}Ce, ^{136}Ce and ^{139}La. The new levels continue the trends of the neighboring even–even nuclides smoothly. These systematics of the ground-state bands in the region $50 < N, Z < 82$ are not disturbed by expected subshell closure effects. (auth)

21763 NEGATIVE PARITY LEVELS IN ^{103}Rh VIA COULOMB EXCITATION. Sayer, R. O.; Temperley, J. K.; Eccleshall, D. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Nucl. Phys.; A179: No. 1, 122-40(1972).

Low-lying negative parity levels in ^{103}Rh were Coulomb excited with 7 to 10 MeV ^{4}He ions and 36 to 45 MeV ^{16}O ions to test the weak-coupling core excitation model for two-quadrupole phonon-core states. A Ge(Li) detector was used to observe the de-excitation γ-rays in singles and ^{16}O-γ coincident spectra. Gamma-ray angular distribution measurements taken during ^{4}He ion bombardment established spin values of $^5/_2$ and $^3/_2$ for the 880 and 1277 keV states, respectively. The 848, 880, 920, and 1107 keV levels have properties consistent with the interpretation of coupling a $2p_{9/2}$ proton to the 4^+ and second 2^+ core states. The spectra give some indication of a level at 803 keV previously seen in inelastic proton-scattering work which could be a state arising from coupling to the two-phonon 0^+ core state. (auth)

21764 NEW BETA-DECAYING STATE IN ^{106}In. Metag, V.; Repnow, R.; Durell, J. L. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett.; 38B: No. 1, 19-21(10 Jan 1972).

Activity and $\gamma\gamma$-coincidence spectra have been studied following ^{16}O bombardment of ^{92}Mo. Evidence for the population of a new β-decaying state in ^{106}In with a half-life of 6.26 ± 0.24 min is presented. A partial level scheme of ^{106}Cd is deduced. (auth)

21765 NUCLEAR DATA SHEETS FOR A = 107. Bertrand, F. E.; Horen, D. J. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 7: No. 1, 1-31(Jan 1972).

All literature containing nuclear structure data pertaining to the mass chain A = 107 has been reviewed and evaluated. The main data have been summarized and used to construct level and decay schemes. Overall, the data only allow few, definitive spin and parity assignments to be made. Inconsistencies in the data are noted either by direct comparison or in footnotes. The present compilation might serve as a basis for choosing definitive experiments that would augment our knowledge of nuclei in this mass chain. Data received prior to November 1971 have been included. (auth)

21766 NUCLEAR DATA SHEETS FOR A = 108. Bertrand, F. E. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 7: No. 1, 33-67(Jan 1972).

Nuclear structure data from reaction and radioactivity studies on A = 108 have been evaluated and compiled, updating the 1960 Nuclear Data Sheets. Adopted level properties and decay schemes are presented. The compilers have used footnotes throughout the compilation to point out discrepancies, uncertainties, and the lack of data. It is hoped that this evaluation will serve as the basis for further experiments and calculations which will add to the spectroscopic knowledge in the A = 108 mass chain. All data received before November 1971 have been included. (auth)

21767 NUCLEAR DATA SHEETS FOR A = 112. Raman, S.; Kim, H. J. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 69-93(Jan 1972).

The 1960 version of the Nuclear Data Sheets for A = 112 has been revised on the basis of experimental data received before September 1971. Experimental data from ≈ 75 papers, comparisons with theory, arguments for J^π assignments, and detailed level schemes are presented. In this mass chain, only the level structure of ^{112}Cd has been experimentally studied to any appreciable extent. (auth)

21768 STUDY OF NUCLEAR STRUCTURE NEAR THE 50 AND 82 NEUTRON CLOSED SHELLS USING THE TAMU TRIGA REACTOR. Hill, John C. (Texas A and M Univ., College Station). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 2(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

21769 ISOMERIC $(g_{9/2})^2$ PROTON STATE IN ^{94}Mo. Brenner, M.; Forsten, K.; Holmlund, O.; (and others) (Aabo Akademi, Turku, Finland). Commentat. Phys.-Math.; 41: 367-70(Dec 1971).

Delayed γ-rays from the decay of ^{94}Tc have been measured. Comparison of the results with ^{93}Nb(^{3}He,d)^{94}Mo data indicates that an observed isomeric level at 2956 keV and a level at 2873 keV in ^{94}Mo are essentially the 8^+ and 6^+ members of the $(1g_{9/2})^2$ proton configuration. Log ft values give the assignment 7^+ for the ^{94}Tc ground state. (auth) (Finland)

21770 DECAY OF 45 SEC AND 83 SEC ^{136}I ISOMERS. Erten, H. N.; Coryell, C. D.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). J. Inorg. Nucl. Chem.; 33: No. 12, 4005-17 (Dec 1971).

The γ-ray spectra of iodine species rapidly isolated from fission were studied using Ge(Li) and NaI(Tl) detectors and 4096 channel analyzers. A total of 17 γ-rays are attributed to the decay of 83 sec ^{136}I. Another species was observed which decayed with 45 sec half-life by emission of 197.3, 220, 370, 381.8, and 1313.3 keV γ-rays. The 1313.3 keV γ-ray, previously attributed only to the decay of 83 sec ^{136}I, was found to have a 45 sec component. This observation characterizes the 45 sec species as an isomer of ^{136}I. A decay scheme is constructed for 45 sec ^{136}I with levels at 1313.3, 1694.1, 1892.4, and 2262.4 keV. A partial decay scheme is proposed for 83 sec ^{136}I. The nature of the levels is discussed and the results are compared with those from previous decay scheme and nuclear excitation studies. (auth)

21771 DETERMINATION OF THE ABSOLUTE DISINTEGRATION RATE OF ^{141}Ce BY $4\pi\beta-\gamma$ COINCIDENCE MEASUREMENTS. Lang, H.; Dieck, E. L. (Zentralinstitut fuer Reaktorexperimente, Juelich, Ger.). Int. J. Appl. Radiat. Isotop.; 23: No. 1, 35-7(Jan 1972).

The measurement of the absolute disintegration rate of ^{141}Ce is described. To solve the coincidence equations the comparison of a $4\pi\beta-\gamma$ measurement and $2\pi\beta-\gamma$ measurement is used. By this method the counting efficiency of the conversion electrons as well as the secondary electrons of the 0.145 MeV γ-quantum in the β-counter can be evaluated. (auth)

21772 GAMMA–GAMMA DIRECTIONAL CORRELATIONS OF THE 552 TO 134 keV CASCADE IN ^{187}Re. Narasimha Raju, M. L.; Khayyoom, A.; Sastry, D. L. (Andhra Univ., Waltair, India). Indian J. Phys.; 44: No. 7, 421-2(Jul 1970).

A conventional slow-fast coincidence scintillation assembly was used to measure the angular correlation for the 552–134 keV $\gamma-\gamma$ cascade in ^{187}Re. The results are consistent with a spin assignment of 512 to the 686-keV level. The results are compared with previous experimental data. (J.W.R.)

21773 ELECTRON SCATTERING STUDIES OF TIN ISOTOPES. Litvinenko, A. S.; Shevchenko, N. G.; Buki, A. Yu.; (and others) (Physical-Technical Inst., Kharkov). Nucl. Phys.; A182: No. 2, 265-71(1972).

The elastic scattering of (225.0 ± 0.2)-MeV electrons by the nuclei ^{116,118,124}Sn was measured to study the change of the charge density distribution parameters with the number of added neutrons in the nucleus. The obtained results are compared with other electron scattering experiments and muon-capture data. (auth)

21774 DECAY OF ^{112}Ag. Wallace, G. (Inst. of Nuclear Sciences, Lower Hutt, New Zealand); McCallum, G. J.; Chapman, N. G. Nucl. Phys.; A182: No. 2, 417-27(1972).

The γ radiation following the decay of ^{112}Ag was studied with a Ge(Li) detector. A total of 76 γ rays was observed. The γ−γ coincidence and angular-correlation relations involving the 617-keV 2^+-0^+ transition were measured using Ge(Li)−NaI(Tl) and NaI(Tl)−NaI(Tl) detectors. These results were used to confirm spins and parities of some levels of ^{112}Cd in the proposed decay scheme. Cross sections for ^{112}Ag production by ^{115}In(n,α) and ^{112}Cd(n,p) reactions were measured; the ^{112}Ag half-life was determined as 3.14 ± 0.02 h. (auth)

21775 MEASUREMENT OF MEAN LIFETIMES OF COULOMB-EXCITED NUCLEAR STATES USING THE PLUNGER RECOIL-DISTANCE TECHNIQUE. Nord, Russell Harry. Madison, Wis.; University of Wisconsin (1971). 78p. University Microfilms Order No. 71-25,207.

Thesis.

A technique was developed recently by Alexander, Allen, and Healey for direct measurement of nuclear state lifetimes in the 1 to 100 picosecond range. Originally used to study excited states produced in nuclear reactions, this technique, known as the "plunger method," has been applied, in the present work, to states produced by Coulomb excitation. This thesis reports the development of the apparatus, both physical and mathematical, required to make such lifetime measurements. The lifetimes measured are as follows: ^{109}Ag[414,($^5/_2^-$)], 55.2 ± 1.6 ps.; ^{112}Cd (617,2^+), 8.3 ± 0.4; ^{194}Pt(328,2^+), 72.9 ± 3.1; ^{195}Pt[211,($^3/_2^-$)], 76 ± 13; ^{195}Pt[239,($^5/_2^-$)], 116 ± 5; and ^{196}Pt(356,2^+), 51 ± 5. (Diss. Abstr. Int., B)

21776 DIRECT MEASUREMENT OF THE TOTAL CROSS SECTIONS FOR NEUTRONS INCIDENT ON TARGETS OF DOSIMETRIC IMPORTANCE IN THE MOMENTUM RANGE 900 TO 3000 MeV/c. Schimmerling, Walter. New Brunswick, N. J.; Rutgers--The State Univ. (1971). 81p. University Microfilms Order No. 72-867.

Thesis.

Total cross sections have been measured for neutrons on 15 targets: 12 selected elements, muscle-tissue equivalent plastic, shielding concrete, and plastic scintillator. The momenta of the neutrons were determined from their time of flight. The momentum range extended from 900 to 3000 MeV/c and was divided into 17 intervals in accordance with the resolution of the timing apparatus. Statistical uncertainties are typically less than 3%. The dependence of the total cross sections on the atomic weight of the targets can be approximated by an $A^{0.75}$ law in contrast with the assumption of an $A^{\frac{2}{3}}$ law made in recent calculations of the dose due to high energy neutrons. The momentum dependence of the cross sections is found similar to that of neutron-proton cross sections, in agreement with findings at higher momenta. In addition to their utility in nuclear physics, these results provide data of importance in the design of shielding for high energy accelerators and space vehicles, and in calculations of absorbed dose. (Diss. Abstr. Int., B)

21777 THERMAL NEUTRON CAPTURE CROSS SECTIONS OF SOME REACTOR-PRODUCED RADIONUCLIDES. Elgart, Myron F. New York; City Univ. of New York (1971). 76p. University Microfilms Order No. 72-988.

Thesis.

A technique has been developed for the determination of thermal neutron capture cross sections of radioactive nuclides. The simultaneous production, decay and burnup of a radioactive nuclide in the core of a nuclear reactor has been studied. The Westcott formalism, which is based on the technique of activation, has been applied to this burnup technique, with the following results. ^{128}I: σ = 20,000 barns, σ_0 = 5960 barns, RI = 40,600 barns; ^{124}Sb: $\hat{\sigma}$ = 6290 barns, σ_0 = 2990 barns, RI = 10,200 barns; and ^{58}Co: $\hat{\sigma}$ = 4480 barns, σ_0 = 2310 barns, RI = 6890 barns. Results for ^{128}I have not been previously reported. The results for ^{124}Sb have determined the Westcott parameters for this nuclide, which were previously in doubt. The results for ^{58}Co show that previous work using this nuclide as a measure of the fast neutron flux is in error. (Diss. Abstr. Int., B)

21778 ISOMER SHIFTS AND CHANGE OF THE NUCLEAR CHARGE RADII OF ^{99}Ru AND ^{101}Ru. Potzel, W. (Technische Univ., Munich); Wagner, F. E.; Kaindl, G.; Moessbauer, R. L.; Seltzer, E. pp 691-7 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

From isomer shifts of the 127-keV γ rays of ^{101}Ru in Ru metal, RuO_2, and $[Ru(NH_3)_4(HSO_3)_2]$ and from the corresponding shifts of the 90-keV γ rays of ^{99}Ru, the ratio of the changes of the mean square nuclear charge radii, $\delta\langle r^2\rangle$ [127 keV]/$\delta\langle r^2\rangle$ [90 keV] = 1.78 ± 0.26, was obtained. Using free-ion relativistic self-consistent-field calculations of electron densities, one estimates $\delta\langle r^2\rangle$ [90 keV] ≈ 2.5×10^{-2} and $\delta\langle r^2\rangle$ [127 keV] ≈ 4.5×10^{-2}. (auth)

21779 RECOIL INTO VACUUM. Nordhagen, Rolf (Univ. of Oslo). pp 893-20 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A review is presented of the perturbed angular correlations in nuclei recoiling into vacuum. The hyperfine interaction in highly excited free atoms in vacuum is discussed, and the use of the interaction to measure the magnetic moment of excited nuclear states and to study the nuclear alignment for correction of experimental measurements is considered in detail. 17 references. (D.L.C.)

21780 HYPERFINE INTERACTIONS OF FAST RECOIL NUCLEI IN GAS. Sprouse, G. D. (State Univ. of New York, Stony Brook). pp 931-60 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

An excited nucleus ejected at high velocities from a target into gas goes through different charge states and different atomic configurations. The hyperfine interaction fluctuates and is described well by the theory of Abragam and Pound. The observations are consistent with a pure magnetic interaction. Accurate g-factor ratios of states with different lifetimes can be obtained if the perturbation is averaged over the same length of time for both states. The velocity dependence of the effective field and the use of isoelectronic ions are discussed. New observation techniques are considered. 26 references. (D.L.C.)

21781 VELOCITY DEPENDENCE OF THE ATTENUATION MECHANISM FOR HIGHLY IONIZED IONS RECOILING INTO VACUUM. de Boer, J.; Rogers, J. D.; Steadman, S. (Rutgers-The State Univ., New Brunswick, N. J.). pp 964-5 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Measurements of angular distributions of gamma rays from Coulomb-excited ^{114}Cd nuclei recoiling into vacuum were made as a function of velocity of the recoil ion. ^{16}O and ^{32}S ions of energies between 28 and 75 MeV were used to bombard thin foils of ^{114}Cd. The angular distributions were compared to first-order C. E. theory to derive values of the attenuation coefficients G_2 and G_4 as a function of recoil velocity and the average charge state of the recoil ion. Results indicate that atomic shell effects may still be important. The atomic state corresponding to 12 charges removed, where the dependence on v/c in the curves is greatest, is that of neutral krypton. (D.L.C.)

21782 MAGNETIC MOMENT DETERMINATION AT PRE-SET TRAVEL TIMES IN THE RECOIL-INTO-GAS METHOD. Miller, T. R.; Sprouse, G. D.; Bond, P. D.; (and others) (Stanford Univ., Calif.). pp 977-80 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The recoil-into-gas method, with a stopper after the target to restrict the travel times to values ≤ the nuclear lifetime, was applied to the 55-psec 414-keV ($^5/_2^-$) and 9-psec 309-keV ($^3/_2^-$) levels of ^{109}Ag. Coulomb excitation by 52-MeV ^{35}Cl ions was used. The perturbation of the gamma-ray correlation (90°/0° ratio) was determined at various stopper distances and He gas pressures. The curves were fitted with the theory of Abragam and Pound and values of ωτ were extracted. The results indicate that the hyperfine field of the ($^5/_2^-$) state is time-dependent and decreases with time. (D.L.C.)

21783 HYPERFINE INTERACTIONS IN EXCITED NUCLEI. VOLUME 4. Conference Held at Rehovot and Jerusalem, Israel, September 6–11, 1970. Goldring, Gvirol; Kalish, Rafael (eds.). New York; Gordon and Breach Science Publishers Inc. (1971). 392p. (CONF-700933-(Vol.4)).

Twenty papers and three tabulations of nuclear data are included. The two sessions covered hyperfine interactions in stripped atoms (IMPAC, quadrupole interactions, transient fields) and nuclear physics (magnetic moments). The tables contain changes in nuclear mean square charge radius, hyperfine fields, and nuclear moments. An author index to all four volumes is included. Separate abstracts were prepared for eleven of the papers; for two of the other papers, see NSA 25: 12429 and 43469. (D.L.C.)

For abstracts of individual papers see: 21784–21788, 21843, 21844, 21954, 21955, 22147, and 22148.

21784 QUADRUPOLE MOMENT OF ^{114}Cd: A TEST CASE FOR THE REORIENTATION EFFECT. Smilansky, U. (Weizmann Inst. of Science, Rehovot, Israel. Max-Planck-Institut, Heidelberg). pp 1091-1118 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A review is presented on reorientation measurements of the quadrupole moment of the first excited state in ^{114}Cd. Some unpublished recent data is included. Uncertainties in the results, due to difficulties associated with the reorientation effect, are discussed. (J.W.R.)

21785 MAGNETIC MOMENT OF THE 2761-keV 8^+ STATE IN ^{92}Mo. Cochavi, S.; McDonald, J. M.; Fossan, D. B. (State Univ. of New York, Stony Brook). pp 1170-2 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Time-differential perturbed angular correlation techniques were used to measure the magnetic moment of the 2761-keV 8^+ state in ^{92}Mo populated in the ^{90}Zr(α,2h) reaction. A fast-slow coincidence scintillation setup was used. A value of 11.2 ± 0.6 hm was obtained. (J.W.R.)

21786 HALF-LIFE AND MAGNETIC MOMENT OF 93-keV ($^9/_2^+$) LEVEL IN ^{103}Rh. Baba, C. V. K. (Bhabha Atomic Research Centre, Trombay, India); Bhattacherjee, S. K.; Jain, H. C. pp 1173-6 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The half-life of the 93-keV level in ^{103}Rh was determined from $\gamma-\gamma$ and $\beta-$ce coincidence measurements. A value of 1.13 ± 0.03 nsec was obtained. The perturbed angular correlation technique was used to measure the g-factor for the same level. A value of g = 1.38 ± 0.20 resulted. (J.W.R.)

21787 g-FACTOR MEASUREMENTS FOR THE 160 μs STATE IN ^{115}Sn AND 340 μs STATE IN ^{117}Sb EXCITED BY PULSED-BEAM BOMBARDMENTS ON LIQUID METALLIC TARGETS. Ivanov, E. A.; Pascovici, G. (Inst. of Atomic Physics, Bucharest). pp 1180-4 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Spin rotation measurements were used to determine g-factors for ^{115m}Sn($T_{\frac{1}{2}}$ = 160 μs) and ^{117m}Sb($T_{\frac{1}{2}}$ = 340 μs). The isomeric states were excited by (α,2n) reactions on liquid metal targets of ^{113,114}Cd and ^{115}In using a pulsed 24-MeV α beam. Time differential angular correlation measurements were made as the states precessed in a weak magnetic field. The deduced g-factors were compared with predictions of the Schmidt model. (J.W.R.)

21788 TABLE OF NUCLEAR MOMENTS. Shirley, Virginia S. (Univ. of California, Berkeley). pp 1255-1336 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

This table is an up-dated extension of the Table of Nuclear Moments published in 1968. It contains nuclear magnetic and quadrupole moments reported as of August 1970. Values from the 1968 table which have been superseded by more accurate results have been omitted unless they are important for sign determinations or unless they show a discrepancy possibly due to differing experimental methods. (auth)

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Refer also to abstracts 21649, 21717, 21723, 21741, 21749, 21788, 21841, 22151, and 22159.

21789 (AE–441) NEUTRON CAPTURE GAMMA RAY CROSS SECTIONS FOR Ta, Ag, In, AND Au BETWEEN 30 AND 175 keV. Hellstroem, J.; Beshai, S. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Nov 1971. 31p. Dep. NTIS (U. S. Sales Only).

A new detector was used to determine neutron capture gamma ray cross sections for Ta, Ag, In and Au. The results are listed and discussed together with associated problems. The energy range from 30 to 175 keV is considered. (auth) (Sweden)

21790 (COO–1779–68) DECAY OF ^{170}Lu TO LEVELS IN ^{170}Yb. Camp, David C. (California Univ., Livermore. Lawrence Radiation Lab.); Bernthal, Fred M. (Michigan State Univ., East Lansing). 6 Aug 1971. 118p. (UCRL–72295). Dep. NTIS.

The locations of 70 energy levels in ^{170}Yb were deduced from Compton suppressed γ-ray singles, three-crystal γ-ray pair, conversion electron, and Ge(Li)–Ge(Li) $\gamma-\gamma$ coincidence measurements on the EC $-\beta^+$ decay of ^{170}Lu. Both chemically separated and isotropically separated sources of ^{170}Lu were used in collecting the data. A total of 550 γ-ray transitions were observed in the ^{170}Lu decay spectrum, 220 of which are definitely assigned to the ^{170}Yb-level scheme from 112 coincidence spectra. These definitive transitions account for 93% of the total observed γ-ray intensity. An additional 118 γ-ray transitions were placed on the basis of excited-state energy differences. Eight EO transitions were observed in the conversion electron data. Each of four excited O^+ states identified has less than 1% beta decay feeding from the O^+ parent. Spin and parity assignments are proposed for 46 levels in addition to the ground-state rotational band members. The ^{170}Yb level structure is compared with available theoretical calculations, and a preliminary interpretation of several features of the decay scheme is presented. (auth)

21791 (FRNC-TH–120) DETERMINATION OF GYROMAGNETIC FACTORS FROM LIFETIME MEASUREMENTS WITH ^{157}Gd, ^{167}Er, ^{173}Yb, AND ^{175}Lu NUCLEI. ESTABLISHMENT OF TIME DEPENDENT PERTURBATIONS IN ^{152}Sm NUCLEI. Vivien, Jean-Pierre (Strasbourg Univ. (France). Faculte des Sciences). 1971. 125p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Gyromagnetic factors were determined from measurements made on the mean lives of excited levels of ^{157}Gd, ^{167}Er, ^{173}Yb and ^{175}Lu nuclei using microwave techniques. The method is analyzed mathematically and a description given of the experimental techniques and the equipment used. The mean life results are analyzed. The spectroscopic data and the values obtained for the gyromagnetic factors, are discussed in the framework of the Nilsson collective model. In the case of low-energy Sm ions recoiling into empty space, time-independent perturbation measurements contradict the hypothesis of a hyperfine field, which is a direct function of the velocity. The establishment of a perturbation effect of the Sm ions recoiling from the target suggests an explanation for the disagreement observed between the multipolarity mixture coefficients deduced from angular distribution and lifetime measurements. (France)

21792 (FRNC-TH–132) EXPERIMENTAL STUDY OF THE COUPLING IN THE ^{165}Er NUCLEUS. Marguier, Georges (Lyon Univ. (France)). 1971. 119p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Coupling in ^{165}Er nuclei was studied experimentally. In order to determine the energy level diagram of this element, the ^{165}Tm decay scheme was studied with $\beta\gamma$ spectrometry utilizing $e-\gamma$ and $\gamma-\gamma$ coincidences. Twenty new low intensity transitions were distinguished and their multipolarities determined. The observed transitions were situated in a decay scheme involving 26 levels, six of which were established during this investigation (62.7 keV $^7/_2^+$; 97.9 keV $^9/_2^+$; 519.1 keV $^5/_2^+$; 534.9 keV $^3/_2^+$; 1416.8 keV $^1/_2^-$ or $^3/_2^-$, 1527.5 keV $^1/_2^-$ or $^3/_2^-$). The structure of excited ^{165}Er states was studied. Negative parity levels were characterized by N = 5 orbits of the Nilsson model. Results are given for the (523), (512) and (505) orbits. The Coriolis coupling between orbits of the $i(^{13}/_2)$ shell and the $\Delta N = 2$ coupling between the (660) and (400) orbits are extremely important in the interpretation of positive parity levels. All the predicted orbits were identified except the (633) orbit. (France)

21793 (LYCEN–7147) STRUCTURE OF ^{174}Hf DEDUCED FROM THE ($\beta^+-\epsilon$) DECAY OF ^{174}Ta. Emsallem, Andre (Lyon

Univ. (France). Institut de Physique Nucleaire). Jul 1971. 59p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Lyon Univ. (France).

Deformed even–even nuclei were considered. Levels of ^{174}Hf resulting from the β^+ decay of ^{174}Ta were studied. There were 16 new levels identified. The spin and parity were determined for 10 of these levels. An interpretation is proposed for certain levels. (France)

21794 ^{176}Hf LEVEL PRODUCED BY THE DECAY OF ^{176}Ta. Broda, R.; Valyus, V.; Zvol'ski, I.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 4, 707-18(Apr 1971). (In Russian).

The conversion spectra of electrons, positrons, and γ radiation were studied for the ^{176}Hf state arising from the decay of ^{176}Ta. A scheme for the decay of ^{176}Hf is proposed. Discussion of the results is centered around states with $K^\pi = 0^+$ and 2^-, and $I^\pi = 1^-$ or 1^+. (K.S.W.)

21795 DECAY SCHEME OF ^{177}Lu EXCITED BY THE (nγ) REACTION. Beitin, M. R.; Bondarenko, V. A.; Kramer, N. D.; (and others) (Inst. of Physics, Riga). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 4, 759-69(Apr 1971). (In Russian).

A level scheme is proposed for representing the rotational bands of ^{177}Lu. Discussion is centered around the rotational bands $^7/_2^+$ [404], $^5/_2^+$ [402], the transition between these two, $^9/_2^-$ [514], $^1/_2^+$ [411], $^1/_2^-$ [541], and the state $^7/_2^-$ [523]. The system of triquasi-particle levels of ^{177}Lu is also presented. (K.S.W.)

21796 NEUTRON ENERGY-DEPENDENT CAPTURE GAMMA-RAY YIELDS IN TANTALUM AND TUNGSTEN. Yost, K. J. (Purdue Univ., Lafayette, Ind.); White, J. E.; Fu, C. Y.; Ford III, W. E. Nucl. Sci. Eng.; 47: No. 2, 209-20(Feb 1972).

Gamma-ray yields as a function of neutron energy for tantalum and tungsten have been generated with a combined experimental and and theoretical approach. The results are presented in a format that would facilitate use in coupled neutron gamma-ray transport calculations. In the case of tungsten, pronounced variations in the capture yield spectra were noticed above 3.0 MeV. On the other hand, only slight variations in the yield spectra were evident for tantalum. The results have been compared with integral gamma-ray yield measurements and the agreement is favorable. (auth)

21797 MAGNETIC MOMENTS OF EXCITED STATES IN ^{188}Os AND ^{192}Os. Sie, Soey H. New Haven; Yale Univ. (1971). 205p. University Microfilms Order No. 71-31-011.

Thesis.

The technique of perturbed angular correlation following ion implantation by Coulomb excitation has been applied to measure the g-factors of several excited states in ^{188}Os and ^{192}Os. The excited nuclei were implanted into a magnetized iron backing, where they experienced magnetic perturbations arising from the transient field during the flight and the hyperfine field after the stopping, resulting in both attenuation and precession of the angular distribution pattern. Various problems associated with this technique have been explored, such as the target heating by the beam, the saturation of the iron backing and the effect of interfering quadrupole interaction. The transient field effect was deduced from a comparison of the $2^{+\prime}$ state in ^{188}Os precessions measured here with that obtained by radioactivity. The g-factors of the 2^+, 4^+ in both isotopes studied and of the $2^{+\prime}$ state in ^{192}Os were derived after exclusion of the transient effect. The apparent subnormal 2^+ state precession associated with the value is attributable to the effect of interfering random quadrupole field interaction, arising from radiation damage by the recoiling nucleus. Additional evidence, from this experiment and from others, supports this postulate. For the 4^+ states, the effective precessions observed were small, as the result of comparable magnitude of the opposing transient and static effects. The resulting errors in the g-factors of these states therefore are large, rendering comparison with model predictions difficult. The 2^+ and $2^{+\prime}$ g-factors are compared with several microscopic model calculations as well as one macroscopic model, revealing generally good agreement. This fact was interpreted as supporting the contention that the pairing correlation is the dominant mechanism in reducing the collective g-factors from the hydrodynamic value of Z/A. (Diss. Abstr. Int., B)

21798 EFFECTS OF ELECTRON SHELL RECOVERY AND RELAXATION MEASURED BY PAC WITH SHORT-LIVED NUCLEAR STATES OF THE RARE EARTH ISOTOPES. Waeppling, R.; Karlsson, E.; Carlsson, G.; Bajaj, M. M. (Univ. of Uppsala). pp 99-102 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The electron shell recovery and spin relaxation time for ^{160}Dy following ^{160}Tb decay were determined by the method of perturbed angular correlations in a $TbAl_2$ crystal. The anisotropy of the angular correlation for the 1178-87 keV cascade was measured at six temperatures between 4.2°K and room temperature. The angular shift for a polarized sample was measured at seven temperatures from 1.5 to 130°K for the 299-966 keV cascade. (J.W.R.)

21799 DIRECTIONAL CORRELATION MEASUREMENTS ON THE DECAY OF ^{176}Ta. Boddendijk, H. G.; Idzenga, S.; Timmerman, G.; Verheul, H. (Vrije Univ., Amsterdam). pp 159-62 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Directional correlations were measured for all cascades involving strong γ rays or internally converted transitions in ^{176}Hf following the decay of ^{176}Ta. The results were used to assign K values and transition multipolarities in ^{176}Hf. (J.W.R.)

21800 SOME ASPECTS OF DIRECTIONAL CORRELATION MEASUREMENTS IN ^{152}Sm. Doubt, H. A.; Hamilton, W. D. (Univ. of Sussex, Brighton, Eng.). pp 162-6 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Gamma-gamma and γ-e directional correlations were measured for the 1408-122 keV and 245-122 keV cascades in samarium-152 following the decay of europium-152. The results were compared with previous studies. Some implications concerning the ^{152}Sm particle parameters are discussed. (J.W.R.)

21801 EO-CONTRIBUTION TO THE 689K-122 γ ANGULAR CORRELATION IN ^{152}Sm. Stefansson, V.; Sergeev, V.; Becker, J.; Holmberg, L. (Univ. of Stockholm). pp 166-8 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters–Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The EO/E2 mixing parameter for the 689 keV transition in ^{152}Sm was determined from angular correlation measurements on the 689-122 keV cascade. Both solid and liquid ^{152}Eu sources were used. The results are compared with previous studies. (J.W.R.)

21802 ELECTRON–GAMMA ANGULAR CORRELATIONS OF THE 203 TO 113 keV CASCADE IN ^{177}Hf. Holmberg, L.; Stefansson, V. (Univ. of Stockholm). pp 168-73 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Electron-gamma and γ–γ angular correlations for the 208-113 keV cascade in ^{177}Hf were measured. Possible deviations from the normal values for the conversion electron particle parameters were studied. No evidence for the existence of a penetration contribution for the conversion process in this cascade was found. (J.W.R.)

21803 DETERMINATION OF E2/M1-MIXING PARAMETERS FOR COLLECTIVE TRANSITIONS IN DEFORMED NUCLEI. Lange, Juergen (Univ., Bonn). pp 242-5 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Angular correlation measurements for energy-level transitions between K = 2 and K = 0 bands in ^{152}Sm, ^{154}Gd, ^{160}Dy, and ^{172}Yb were performed using a Ge(Li) detector. The results were used to obtain reduced mixing parameters. A systematic dependence on spin was found. (J.W.R.)

21804 γ–γ DIRECTIONAL CORRELATIONS OF THE 1079-89 AND 2089-89 keV CASCADES IN ^{156}Gd. Collins, E. (Vanderbilt Univ., Nashville); Hamilton, J. H.; Little, P. E.; (and others). pp 245-7 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters–Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

A directional correlation system with NaI and Ge(Li) detectors was used to study the 1079-89 and 2089-89 keV cascades in ^{156}Gd. A spin of O for the 1168-keV level was established from the study of the first cascade. The angular correlation coefficients for the second cascade were used to determine limits on the multipole mixing ratio for the 2089-keV transition. (J.W.R.)

21805 M1–E2 ADMIXTURES IN TRANSITIONS FROM BETA- AND GAMMA-LEVELS IN ^{152}Sm. Ramayya, A. V.; Lourens, W.; van Nooijen, B.; Van Krugten, H. (Delft Univ. of Tech., Netherlands). pp 247-50 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

A magnetic β spectrometer and a high-efficiency, high-resolution Ge(Li) detector were used to measure $e-\gamma$ angular correlations for transitions from β- and γ-vibrational levels in ^{152}Sm. E2–M1 admixtures were obtained for several transitions and compared with theoretical predictions. (J.W.R.)

21806 M2/E1 MIXING RATIO FOR THE ANOMALOUS $\Delta K = 1$ 71.6 keV TRANSITION IN ^{177}Hf. Hrastnik, B.; Basar, I.; Diksic, M.; (and others). (Inst. Rujer Boskovic, Zagreb). pp 251-2 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters–Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Gamma-gamma angular correlations for the 71.6-249.7 keV cascade in ^{177}Hf were measured using Ge(Li) detectors. An M2/E1 mixing ratio was deduced for the 71.6-keV transition and compared with the single-particle estimates of Weisskopf and Nelsson. (J.W.R.)

21807 PERTURBED ANGULAR CORRELATIONS IN PARAMAGNETIC SINGLE CRYSTALS OF RARE-EARTH ETHYLSULFATES. Dirren, H.; Leisi, H. J. (Swiss Federal Inst. of Tech., Zurich). pp 448-50 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The $\gamma-\gamma$ directional correlation of the 1380–81 keV cascade in the decay of ^{166}Ho which was magnetically diluted in single crystals of La-ethyl-sulfate (LaES) and Y-ethylsulfate (YES) was studied. The angular correlation function was measured at room temperature and at 6°K for different orientations of the single crystals. Holmium oxide was irradiated and the crystals were grown afterwards from aqueous solutions, according to different chemical procedures. The measurements were evaluated in terms of attenuation factors G_k. The main features of the results may be summarized as follows: (i) All experiments show a large temperature effect on G_2 and G_4. (ii) The effect of crystal orientation is small in all cases. (iii) No decisive differences for different chemical preparations are observed. (auth)

21808 TIME DIFFERENTIAL STUDIES OF ^{166}Er IN COPPER. Heestand, G. M.; Nielsen, K. Bonde; Ravn, H.; Abildskov, F.; Deutch, B. I. (Univ. of Aarhus, Denmark). pp 513-16 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Time differential angular correlations between the 1760 keV β-ray from the ^{166}Ho ground state to the ^{166}Er first excited state and the 81-keV γ ray for the ^{166}Er $2^+ \rightarrow 0^+$ transition were measured for a ^{166}Dy source implanted in copper. The results were compared with the Abragam–Pound theory and the Blume stochastic model. Neither theory was adequate to explain the experimental data. (J.W.R.)

21809 PARAMAGNETIC RELAXATION FOR ERBIUM IN COPPER. Skaali, B. (Univ. of Copenhagen); Guenther, C.; Herskind, B.; Ravn, H. pp 516-18 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Perturbed angular correlations for the 1380-81 keV γ cascade in ^{166}Er were measured at 77 and 295°K for a ^{166}Dy source implanted in Cu. Attenuation factors were determined and compared with predictions of Abragam and Pound and Blume. The paramagnetic correction factors were determined and compared with theoretical values. (J.W.R.)

21810 HYPERFINE INTERACTIONS OF ^{161}Dy NUCLEI IMPLANTED IN IRON. Inia, P.; de Waard, H. (Univ. of Groningen, Netherlands). pp 519-22 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The hyperfine interactions of ^{161}Dy nuclei in iron were studied by the Moessbauer spectra of the 26-keV transition in ^{161}Dy. A DyF_3 absorber at liquid nitrogen temperature was used. Measurements were made at room temperature and liquid nitrogen temperature for the source. (J.W.R.)

21811 OBSERVATION OF THE QUADRUPOLE INTERACTION AT Ta IN Zr BY TIME-DIFFERENTIAL PERTURBED ANGULAR CORRELATION TECHNIQUE. Kaufmann, E. N. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 600-3 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Time-differential perturbed $\gamma-\gamma$ angular correlations for the 133-482 keV cascade in ^{181}Ta following the decay of ^{181}Hf were measured for a ^{181}Hf source in Zr. Data were collected for several angles between plastic and NaI(Tl) scintillators. The measurements were performed at 77 and 300°K. The observed temperature dependence cannot be explained by the change in lattice constants. (J.W.R.)

21812 HIGH-SPIN STATES IN ^{153}Gd AND ^{152}Gd. Loevhoeiden, G. (Univ. of Oslo); Hjorth, S. A.; Ryde, H.; Harms-Ringdahl, L. Nucl. Phys.; A181: No. 2, 589-608(1972).

The ^{152}Sm(α,xn) reactions were used to populate states in ^{152}Gd and ^{153}Gd. In ^{153}Gd a cascade of E2 transitions is observed which constitutes a strongly distorted positive-parity band up to the member with spin $33/2$. A calculation in which the Nilsson model is extended to include Coriolis coupling accounts only qualitatively for the energies obtained experimentally in this band, and it appears that nonrotational effects may be of some importance. The rotational band built on the $11/2$-[505] Nilsson orbital is also observed. Here the rotor model gives a good account of the experimental energies. In the transitional nuclide ^{152}Gd the ground-state band is populated up to the 12^+ level. The experimental level energies are compared with predictions from various phenomenological models. (8 figures, 9 tables) (auth)

21813 LEVELS OF ^{165}Ho. STUDY OF THE CORIOLIS COUPLING BETWEEN THE $1/2^+$ [411] AND $3/2^+$ [411] BANDS. Mauron, G.; Kern, J.; Huber, O. (Univ., Fribourg, Switzerland). Nucl. Phys.; A181: No. 2, 489-516(1972). (In French).

The level scheme of ^{165}Ho was investigated using the β decays of ^{165}Dy (2.35 h) and ^{165m}Dy (75 s). With the help of a Ge(Li) detector a total of 54 and 12 transitions, respectively, were observed. In the ground-state decay 22 low-energy conversion lines were resolved in the Fribourg double-focusing magnetic spectrometer. With these data it was possible to obtain the multipolarities of several transitions and to construct a scheme of the ^{165}Ho levels having seven rotational bands. The precision in the energy-level determination varies between 3 and 90 eV. Deviation of the simple rotational prediction in the [411↑] and [411↓] bands could be satisfactorily explained by introducing a Coriolis coupling. The wave functions obtained in this way are shown to explain the observed γ-branching ratios and multipolarity mixing ratios very well. The other bands are discussed in terms of the Nilsson model. A very precise energy standard at 995.089 ± 0.008 keV was established. Intensity standards are proposed. (10 figures, 12 tables, 64 references) (auth)

21814 HIGH-SPIN STATES IN ^{153}Gd AND ^{154}Gd FROM (α,x,γ) STUDIES. Rezanka, I.; Bernthal, F. M.; Rasmussen, J. O.; (and others) (Yale Univ., New Haven). Nucl. Phys.; A179: No. 1, 51-64(1972).

By in-beam γ-spectroscopy many new γ-transitions in ^{153}Gd were found. Most transitions can be assigned to two rotational bands, one built on the $11/2^-$ [505] band-head at 171.4 keV and extending up to the $23/2^-$ level at 1587.1 keV, the other built on a 95.2 keV $5/2^+$ band-head at 95.2 keV and extending up to $25/2^+$ at 1197 keV. From angular distributions and γ-branching ratios in the $11/2^-$ band gyromagnetic factor differences $g_K - g_R$ for three cascade γ-transitions were determined. The severely perturbed energy spacings of the even-parity band are discussed in terms of very large Coriolis mixing of the two lowest-lying $i13/2$ Nilsson orbitals. Additional transitions are reported to extend the ground band of ^{154}Gd to the 16^+ level. (auth)

21815 EMPIRICAL EVIDENCE FOR CORIOLIS COUPLING OF OCTUPOLE STATES IN ^{172}Yb. O'Neil, R. A.; Burke, D. G. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A182: No. 2, 342-58(1972).

The nucleus ^{172}Yb was studied using the (^{3}He, α) and (d, t) reactions on targets of ^{173}Yb. Beams of 12-MeV deuterons and 24-MeV ^{3}He particles were obtained from the McMaster FN Tandem Van de Graaff accelerator, and the reaction products

were analyzed with a magnetic spectrograph. The (^{3}He, α) reaction was particularly useful in identifying states formed by coupling the $\frac{1}{2}^+$[633] transferred neutron to the $\frac{5}{2}^-$[512] target ground state. The $K^\pi = 1^-$ coupling of these orbitals makes up a large fraction of the $K^\pi = 1^-$ octupole vibration, which was found to be strongly perturbed by Coriolis coupling with other octupole states. The most striking feature is that Coriolis coupling with the $K^\pi = 0^-$ octupole band, which has only odd-spin rotational members, produces a significant odd–even shift in the rotational spacing of the $K^\pi = 1^-$ band. These results are in excellent agreement with the predictions of Neergård and Vogel. The observation of the $K^\pi = 6^-$, $\frac{1}{2}^+$[633] + $\frac{5}{2}^-$[512] rotational band up to spin I = 9 confirmed the previous assignment for the bandhead of this configuration to the isomeric state at 1551 keV. The $K^\pi = 3^+$ and $K^\pi = 8^+$, $11/2^-$[505] ± $\frac{5}{2}^-$[512], two-neutron configurations were also identified. In addition, several other new assignments are tentatively proposed. (auth)

21816 INVESTIGATION OF THE DECAY OF SOME DEFORMED AND TRANSITIONAL NUCLEI (^{185}Os, ^{193}Os, ^{184}Ir, ^{186}Ir, ^{188}Ir). Badica, T. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 8, 877-908(1971). (In Rumanian).

After a brief introduction, experimental techniques for measurement of gamma singles and concidence spectra are described. Investigations of the decay schemes ^{185}Os → ^{185}Re and ^{193}Os → ^{193}Ir are discussed, as well as the probabilities for $21^+ \rightarrow 0^+$ transitions in ^{184,186,188}Os. (19 figures, 10 tables, 47 references) (R.W.R.)

21817 EXPERIMENTS ON PARITY NON-CONSERVATION IN NUCLEAR FORCES IN ^{180}Hf, ^{159}Tb, ^{203}Tl, AND ^{181}Ta. Lipson, Edward David. Pasadena, Calif.; California Inst. of Tech. (1971). 86p. University Microfilms Order No. 72-477.

Thesis.

Weak interaction theories of the "current-current" form predict a weak parity-non-conserving force between nucleons. One manifestation of such a force is the net circular polarization of γ rays from unoriented nuclei. The circular polarization for four favorable nuclear γ transitions was measured.

^{180}Hf 501 keV γ: $P_\gamma = (-23 \pm 6) \times 10^{-4}$
^{159}Tb 363 keV γ: $P_\gamma = (-1 \pm 5) \times 10^{-4}$
^{203}Tl 279 keV γ: $P_\gamma = (-0.04 \pm 0.10) \times 10^{-4}$
^{181}Ta 482 keV γ: $P_\gamma = (-0.031 \pm 0.025) \times 10^{-4}$

The measurements were performed with a forward-scattering rapidly-reversing Compton polarimeter and a phase-sensitive detection system. The analyzing efficiency of the Compton polarimeter, including effects of multiple scattering, was determined by Monte Carlo calculations. It was necessary in most experiments to apply corrections for polarized bremsstrahlung associated with β decays. Calculations of bremsstrahlung effects were verified by experiments on ^{198}Au and ^{177}Lu. The residual asymmetry of the polarimeter itself was determined by control experiments on ^{103}Ru. The values of P_γ obtained are compared with related experiments and discussed in the framework of nuclear and weak-interaction theories. (Diss. Abstr. Int., B)

21818 PRECESSION MEASUREMENTS OF 6^+ AND 8^+ ROTATIONAL STATES IN EVEN Dy ISOTOPES. Kalish, Rafael (Massachusetts Inst. of Tech., Cambridge. Technion–Israel Inst. of Tech., Haifa); Kossler, W. J. pp 123-8 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

High rotational states of ^{158}Dy, ^{160}Dy, and ^{162}Dy were produced by α irradiation of a natural Gd target. The precession angles of the excited nuclei in the hyperfine fields were measured. Preliminary results for the 6^+ and 8^+ states are reported: the perturbed angular correlation measurements were carried out at 77, 170, 257, and 300°K. The g factor of the 6^+ state of ^{158}Dy was determined to be 0.36 ± 0.07. The effective hf fields were deduced, and the transient field effects are discussed. (D.L.C.)

21819 MOESSBAUER ISOMER SHIFTS AND CHANGES OF NUCLEAR CHARGE RADII IN $^{182\ 184\ 186}$W. Wagner, F. E.; Schaller, H.; Felscher, R.; Kaindl, G.; Kienle, P. (Technische Univ., Munich). pp 603-12 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A study of the isomer shifts of the 100-keV, 111-keV, and 122 keV γ rays of ^{182,184,186}W yielded $\delta\langle r^2\rangle[^{182}W, 100\ keV] : \delta\langle r^2\rangle[^{184}W, 111\ keV] : \delta\langle r^2\rangle[^{186}W, 122\ keV] = 1.00 : (-0.81 \pm 0.22) : (-0.71 \pm 0.34)$ for the ratio of changes of nuclear charge radii. For ^{182}W, one estimates $\delta\langle r^2\rangle/\langle r^2\rangle[^{182}W, 100\ keV] \approx -0.16 \times 10^{-14}$ from the shifts in hexahalogen complexes. (auth)

21820 NUCLEAR CHARGE RADIUS CHANGE IN ^{161}Dy. Cohen, R. L.; West, K. W. (Bell Telephone Labs., Murray Hill, N. J.). pp 613-17 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The hfs of the 26.1-keV transition in ^{161}Dy was used to make extremely precise determinations of $g_e/g_g = -1.236 \pm 0.002$ and $Q_e/Q_g = 0.9995 \pm 0.0002$. The isomer shift observed between Dy^{3+} and Dy^{4+} corresponds to $\delta\langle r^2\rangle = 0.73 \times 10^{-2}$ fm^2, assuming $\Delta|\psi^2(4^+ - 3^+)| = 4.21 \times 10^{26}$ el cm^{-3}. The measured Q_e/Q_g leads to $\delta\beta = -.00017$, which does not explain the observed $\delta\langle r^2\rangle$; thus, the effects of the odd particle transition on the core cannot be neglected. These particle-core effects were estimated, and the ground-state charge radius was calculated. The hfs parameters in Dy metal at 6°K were determined to be $g_g\mu_N H = 40.4 \pm 0.2$ mm/sec and $e^2qQ = 125.7 \pm 0.6$ mm/sec. At 78 to 180°K, the spectrum is distorted by slow relaxation of the Dy ion electronic states. (D.L.C.)

21821 CHANGE OF NUCLEAR CHARGE RADIUS IN EVEN AND ODD Yb ISOTOPES. Shenoy, G. K. (Argonne National Lab., Ill.); Kalvius, G. M.; Henning, W.; Baehre, G.; Kienle, P. pp 699-705 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Changes in mean square nuclear charge radius $\Delta\langle r^2\rangle$ for the $2^+ \rightarrow 0^+$ rotational transitions in ^{170,172,174}Yb and in the $3/2^- \rightarrow \frac{1}{2}^-$ and the $\frac{5}{2}^- \rightarrow \frac{1}{2}^-$ rotational transitions in ^{171}Yb were determined using Moessbauer spectroscopy. The observed variations of $\Delta\langle r^2\rangle$ indicate an increase in rigidity by adding one pair of neutrons to the A = 170 core, which then remains nearly constant by the addition of a second pair. This result is discussed in the light of microscopic theory. The data for ^{171}Yb show that core excitation alone cannot account for the observed behavior. The unpaired neutron has a substantial influence on $\Delta\langle r^2\rangle$. (auth)

21822 TIME-DEPENDENT ANGULAR CORRELATION MEASUREMENTS FOR THE FIRST 2+ STATE OF ^{150}Sm RECOILING INTO VACUUM. Polga, T.; Roney, W. M.; Kugel, H. W.; Borchers, R. R. (Univ. of Wisconsin, Madison). pp 961-3 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The time dependence of the perturbed angular correlation for the first 2+ state of ^{150}Sm recoiling into vacuum was determined using the recoil distance method. γ rays were detected in coincidence with backscattered 35-MeV ^{16}O ions. The target was a 100 μg/cm^2 layer of ^{150}Sm vacuum evaporated on the reverse side of a 0.25 μm Ni foil. The recoiling ions (with a velocity of 0.013c) were stopped in a 25 μm Cu foil. The $A_2 = 0.648 \pm 0.007$ and $A_4 = 1.183 \pm 0.011$ agree with predicted values. The mean lifetime of the first 2+ state of ^{150}Sm and the t = 0 point of the apparatus were determined using the normal recoil distance technique with a high resolution Ge(Li) detector at zero degrees. The average attenuation coefficients (G_2 and G_4) are shown as a function of time-in-flight. The ratio λ_2/λ_4 is 0.57. (D.L.C.)

21823 TIME-DIFFERENTIAL PERTURBED γ-RAY ANGULAR DISTRIBUTION FROM Yb NUCLEI RECOILING INTO VACUUM. Brenn, R.; Lehmann, L.; Spehl, H. (Univ., Freiburg i. B.). pp 966-7 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The attenuation of the γ-ray angular distribution following recoil into vacuum after Coulomb excitation of Yb 2^+ levels with 16-MeV Ne ions was observed. A time-of-flight technique has been used. The anisotropy is completely destroyed within a time interval of about 200 psec due to time-dependent hyperfine interaction of the nucleus with the ionized and excited atomic surroundings. Least-squares fits to the experimental data have been carried out using (a) the Abragam and Pound theory and (b) attenuation coefficients of the form $G_2(t) = (1 - \kappa_2)\exp(-\lambda_a t) + \kappa_2 \exp(-\lambda_b t)$, with the matrix elements $Q_{m \rightarrow m'}$ as fit parameters. (D.L.C.)

21824 POSSIBLE TDPAC FOLLOWING LOW-ENERGY RECOIL INTO VACUUM. Armbruster, R.; Dar, Y.; Gerber, J.;

Vivien, J. P. (CRN, Strasbourg). pp 973-6 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A time-differential PAC measurement was made on ^{152}Sm (2^+, 122-keV level) recoiled from 40- and 80-$\mu g/cm^2$ Sm_2O_3 targets. The microwave method of measuring lifetimes of nuclear excited states was used. The time spectrum of the thicker target agrees very well with that calculated for a normal nuclear decay, while for the thin target, a small component (~1%) of fast decay with τ_2 = 35 psec is found. (D.L.C.)

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Refer also to abstracts 20169, 20424, 21649, 21651, 21714, 21717, 21775, 21788, 21789, 21797, 21816, and 21817.

21825 (COO-1779-42) GAMMA RAY SPECTROSCOPIC STUDIES OF STATES IN NEUTRON-DEFICIENT Pb AND Tl ISOTOPES. Doebler, Raymond Edwin (Michigan State Univ., East Lansing. Dept. of Chemistry). 1970. 336p. Dep. NTIS.

Thesis.

In an effort to obtain more information on the energy level systematics in the neutron-deficient lead and thallium isotopes, γ-ray spectroscopic studies have been made on the following isotopes: ^{204m}Pb, ^{203m}Pb, ^{202m}Pb, ^{201}Pb, ^{200}Pb, and ^{199}Pb. A search was also made for an isomeric state in ^{200}Pb. These studies were conducted largely with Ge(Li) detectors in singles, in coincidence and anticoincidence arrangements with NaI(Tl) detectors, and in two-dimensional, Ge(Li)-Ge(Li), multiparameter systems. Using a single-crystal Ge(Li) conversion coefficient spectrometer, K-conversion coefficients for the 899.2-keV E2 and the 911.7-keV E5 transitions in ^{204m}Pb were measured. In the study of the 6.1-s isomer, ^{203m}Pb, a 5.1-keV M2 transition was found to compete with the 825.2-keV M4 isomeric transition. After correcting for this branching decay, the M4 transition probability was found to be consistent with those of the other M4 transitions in the lead region. Six new γ transitions were assigned to the decay of ^{202m}Pb and a new level has been proposed at 1550-keV in ^{202}Tl, populated by electron-capture from the isomeric state. After an intensive search, an upper limit of ≈1 s was placed on any possible isomeric state in ^{200}Pb. Low-spin states in ^{200}Tl were studied via the decay of 21.5-h ^{200}Pb. Nineteen γ transitions were assigned to this decay and all have been placed in a consistent level scheme. States in ^{200}Tl populated in the decay of ^{200}Pb lie at 0, 147.63, 257.19, 289.24, 289.92, 450.56, 525.54, and 605.44 keV. A total of 72 γ transitions were observed in the decay of 9.4-h ^{201}Pb. Excited states in ^{201}Tl accommodating 65 of these transitions were placed at 331.15, 692.41, 1098.46, 1134.81, 1157.41, 1238.82, 1277.09, 1290.05, 1330.38, 1401.21, 1420.00, 1445.85, 1479.87, 1550.5, 1617.45, 1639.47, 1672.00, 1712.5, and 1755.31 keV. Eighty-nine of the 117 γ transitions assigned to the decay of 90-min ^{199}Pb were placed in a decay scheme with levels at 0, 366.90, 720.26, 1120.90, 1241.67, 1482.25, 1502.00, 1528.2. 1554.10, 1632.00, 1658.47, 1695.25, 1725.4, 1749.6, 1768.5, 1891.0, 1898.1, 1930.4, 1959.45, 1977.8, 2031.5, 2159.0, 2206.7, 2226.5, 2237.3, 2367.3, 2433.5, 2547.4, and 2643.2 keV. Unique spin and parity assignments were made for many of the states observed in these studies, with limits placed on most of the remaining ones. Spin and parity assignments were based on measured conversion coefficients, log ft values, and relative photon intensities. The structures of the states in odd-odd ^{200}Tl are discussed in terms of the coupling of possible single-particle states in adjacent odd-A nuclei. The systematics of the odd-A Tl nuclei, including ^{201}Tl and ^{199}Tl, are discussed in terms of single-particle shell model states coupled to core states of the corresponding Pb nuclei. (auth)

21826 (FRNC-TH-127) MECHANISMS OF α-PARTICLE AND ^{8}Be TRANSFER IN REACTIONS INDUCED BY CARBON IONS ON HEAVY NUCLEI (Bi,Au). Rivet, Marie-France (Paris Univ., Orsay (France)). Oct 1971. 54p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The ^{12}C + Bi and ^{12}C + Au reactions were studied between 60 and 89 MeV. In both these reactions, a large cross section for the ^{8}Be transfer was observed. The cross sections for the production of ^{199}Tl and ^{200}Tl and the production of ^{211}At were also very large: they are attributed to the transfer of an α particle. These two types of transfer are accompanied by an extensive emission of α particles from direct interactions: ^{12}C + Bi → ^{211}Fr + α and ^{12}C + Bi → ^{213}At + ^{8}Be(→2α). (France)

21827 (NP-19045) ON THE VALIDITY OF THE ξ-APPROXIMATION IN THE 0.959 MeV TRANSITION IN ^{198}Au. Krmpotic, F.; Bosch, H. E.; Behar, M.; Cambiaggio, M. C.; Bermudez, G. Garcia; Szybisz, L. (Buenos Aires Univ. (Argentina). Departamento de Fisica. Instituto de Investigaciones Aeronauticas y Espaciales, Buenos Aires (Argentina). Laboratorio de Radiaciones). Dec 1970. 7p. (LR-30). Dep. NTIS (U. S. Sales Only).

A reinvestigation of the nuclear matrix elements for the 0.959-MeV transition in ^{198}Au is made, taking into account the large number and accurate experimental information available. The formulas employed and the computational procedure used in the analysis are similar to those existing in the current literature. The results show that there is no significant deviation from the ξ-approximation, and bounded values for the nuclear matrix elements are obtained. (auth)

21828 (NP-19153) NEW ^{204}Au ACTIVITY AND THE DECAY OF ^{202}Au. Pakkanen, A.; Komppa, T.; Helppi, H. (Jyvaskyla Univ. (Finland). Dept. of Physics). Sep 1971. 16p. Dep. NTIS (U. S. Sales Only).

A new 40 ± 3 s activity, assigned to ^{204}Au, was found by bombarding natural mercury targets with 14 to 15-MeV neutrons. The decay of this nucleus and ^{202}Au ($T_{\frac{1}{2}}$ = 29 ± 3 s) were studied employing Ge(Li), NaI(Tl) and plastic detectors and coincidence systems. No trace of the previously reported 4.0 ± 1.0 s activity of ^{204}Au was observed. (auth) (Finland)

21829 (NP-19166) NEW ^{204}Au ACTIVITY AND THE DECAY OF ^{202}Au. Pakkanen, A.; Komppa, T.; Helppi, H. (Jyvaskyla Univ. (Finland). Dept. of Physics). Sep 1971. 16p. Dep. NTIS (U. S. Sales Only).

A new 40 ± 3 s activity, assigned to ^{204}Au, was found by bombarding natural mercury targets with 14 to 15 MeV neutrons. The decay of this nucleus and ^{202}Au ($T_{\frac{1}{2}}$ = 29 ± 3 s) was studied employing Ge(Li), NaI(Tl), and plastic detectors, and coincidence systems. No trace of the previously reported 4.0 ± 1.0 s activity of ^{204}Au was observed. (auth)

21830 (ORNL-tr-2562) PRODUCTION OF CARRIER-FREE ^{206}Bi FROM LEAD WITH DEUTERONS. Wagner, K. Translated by J. J. Pinajian (Oak Ridge National Lab., Tenn.), from Kernenergie; 6: 122-3(1963). 5p. Dep. NTIS.

An average value of 30 mCi/mA · hr was found for the formation of ^{206}Bi from lead with deuterons. The measurement of activity was followed with a γ-ionization chamber. A value of 18.7 R/hr was calculated as the γ-dose constant. (auth)

21831 ISOMERIC STATES IN NEUTRON-DEFICIENT Po ISOTOPES (A = 200 TO 203) STUDIED BY (HI,x$n\gamma$) REACTIONS. Nagamiya, S.; Inamura, T. (Inst. of Physical and Chemical Research, Saitama, Japan). Nucl. Phys.; A182: No. 1, 84-96 (1972).

High-spin isomeric states in neutron-deficient Po isotopes with mass number A = 200-203 have been investigated by means of the ns time analysis of γ rays between the natural beam bursts from a cyclotron in ^{nat}Pt(^{12}C,x$n\gamma$), ^{nat}Ir(^{14}N,x$n\gamma$) and ^{191}Ir(^{14}N, x$n\gamma$) reactions. The $[\pi h_{\frac{9}{2}}]8^+$ isomeric states have been identified in ^{202}Po and also in ^{200}Po, whose half-lives are determined to be 185 ± 30 ns and 190 ± 60 ns, respectively. Level systematics revealed in the study is discussed. (auth)

21832 MEASUREMENT OF THE DIFFERENTIAL ELASTIC SCATTERING CROSS SECTION OF 662 keV GAMMA RAYS IN LEAD. Sahota, H. S.; Sood, B. S. (Punjabi Univ., Patiala, India). Indian J. Phys.; 44: No. 7, 415-18(Jul 1970).

Elastic scattering of 662-keV gamma rays from cylindrical lead targets has been studied in order to investigate if the scatterer behaves as a homogeneous source of the scattered radiation. It has been observed that for targets with product of linear absorption coefficient and radius of the cylindrical target less than or equal to 0.65 this is essentially true. (auth)

21833 TIME-DIFFERENTIAL STUDY OF AFTER-EFFECTS IN THE DECAY OF ^{197m}Hg. Baeverstam, U.; Othaz, R. (Univ. of Stockholm). pp 97-8 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The time constant for the after-effects interaction following the isomeric transition in ^{197m}Hg was measured. The time constant was determined from a time-differential angular correlation measurement of the 165-134 keV cascade. The results show that the after effect of hole formation is a fast and strong effect which severely perturbs angular correlations. (J.W.R.)

21834 EFFECT OF MULTIPLE SCATTERING OF ELECTRONS ON e^--γ DIRECTIONAL CORRELATIONS. Gupta, N. K.; Sastry,

K. S. R. (Univ. of Massachusetts, Amherst). pp 156-8 of Angular Correlations in Nuclear Disintegration. van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

An attempt was made to check the validity of the Golden and Frankel expression for estimating the correction due to multiple scattering in $e-\gamma$ angular correlations. The attenuations of $e-\gamma$ and $\gamma-e$ correlations associated with the 1063 keV(M4) and 569 keV (E2) cascade transitions in ^{207}Pb for scattering foils of aluminum, niobium, and gold placed in front of a ^{207}Bi thin source were measured using a multichannel $\beta-\gamma$ coincidence spectrometer. The results are generally in agreement with the theory of Golden and Frankel. (J.W.R.)

21835 LOW-LYING LEVEL STRUCTURE OF ^{198}Hg AND ^{200}Hg. Beraud, R.; Berkes, I.; Haroutunian, R.; (and others) (Univ., Lyon). pp 256-61 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Gamma coincidence spectra and $\gamma-\gamma$ angular correlations in the decays of ^{198,198m,200}Tl were measured with a conventional fast-slow system. Lifetimes for the 5^- and 7^- states in ^{198}Hg were measured by the delayed coincidence method. Spins and transition probabilities for low-lying states in ^{198}Hg and ^{200}Hg were determined. The low-lying structure was interpreted in terms of the boson approximation with a residual Q-Q interaction. (J.W.R.)

21836 ANOMALOUS ORBITAL MAGNETISM OF THE PROTON DEDUCED FROM THE MAGNETIC MOMENT OF THE 11^- STATE OF ^{210}Po. Yamazaki, T. (Tokyo Univ. Inst. of Physical and Chemical Research, Yamatomachi, Japan); Nomura, T.; Nagamiya, S.; Katou, T. pp 552-6 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Time-differential angular distributions of γ rays from the decay of the 11^- state of ^{210}Po were measured using a Ge(Li) detector. The ^{208}Pb(α,2n) reaction was used to populate the 11^- state. The γ rays were perturbed in an external magnetic field of 19.05 kG. A g-factor of 1.090 ± 0.016 for the 11^- state was deduced. This gives an anomalous value for the proton g_l^{eff}-factor. The mesonic effect may be the main source of such an anomaly. (J.W.R.)

21837 STROBOSCOPIC DETERMINATION OF THE MAGNETIC MOMENT OF THE 8^+ ISOMERIC STATE IN ^{208}Po. Nagamiya, S. (Inst. of Physical and Chemical Research, Yamatomachi, Japan); Nomura, T.; Yamazaki, T. pp 557-60 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The g-factor of the 8^+ isomeric state in ^{208}Po was measured by the stroboscopic resonance method. A value of 0.902 ± 0.006 was obtained. (J.W.R.)

21838 NEUTRON SCATTERING FROM BISMUTH, STRONTIUM AND SODIUM AT 14.8 MeV. Kuijper, P.; Veefkind, J. C.; Jonker, C. C. (Vrije Univ., Amsterdam). Nucl. Phys.; A181: No. 2, 545-65(1972).

Differential cross sections for the elastic and inelastic scattering of 14.8-MeV neutrons from Bi, Sr, and Na were measured with four neutron detectors participating in a time-of-flight system, which had an energy resolution of 900 keV for the incident neutrons. The whole procedure was checked by scattering from carbon. For the elastic scattering of Bi, Sr, and Na satisfactory optical-model fits were obtained. The absolute cross sections for excitation of collective states are compared to the distorted-wave theory for direct reactions, and a reasonable agreement is found. The nuclear deformation parameters are extracted and compared to the values from other experiments. (14 figures, 11 tables) (auth)

21839 STRUCTURE OF ^{209}Bi AND ^{210}Bi FROM ISOBARIC ANALOGUE RESONANCES IN THE ^{209}Bi(p,p') REACTION. Coffin, J. P.; Stein, Nelson; Cleary, T. P.; King, C. H.; Bromley, D. A. (Yale Univ., New Haven). Nucl. Phys.; A181: No. 2, 337-67(1972).

Excitation functions for proton scattering from ^{209}Bi were measured at 145 and 165° between incident energies of 14 and 21 MeV. The final states were $0.0(9/2^-)$, $0.90(1/2^-)$, $2.83(5/2^-)$ and the septuplet of states between 2.49 and 2.74 MeV based on the 3^- core excitation. Strong isobaric analog resonances in ^{210}Po are observed in all the data. Many features of the elastic resonances, and of the inelastic resonances in the septuplet excitation functions, are found to be remarkably similar to those observed in scattering from ^{208}Pb and from other nuclei in the lead region. The ^{210}Po resonances are attributed to parent states in ^{210}Bi with (π,ν) configurations, and comparisons are made with studies of ^{210}Bi from the (d,p) and (n,γ) reactions. Assignments of (π,ν) configurations up to 1.6 MeV are summarized based on all the existing data. Mixing of the $[h_{9/2}^{\pi}, g_{9/2}^{\nu}]$ and $[f_{7/2}^{\pi}, g_{9/2}^{\nu}]$ configurations in the first two 8^- states of ^{210}Bi is deduced, and comparisons are made with shell-model calculations. Qualitative conclusions are drawn concerning the extent of the mixing and spreading in energy of the (π, ν) configurations. The usefulness of analog resonance studies in cases such as ^{210}Po, where $\Gamma/D \gg 1$ for the analog states, is demonstrated. (9 figures, 3 tables) (auth)

21840 IN-BEAM STUDY OF LIGHT Pb ISOTOPES WITH THE (p,4n) AND (p,6n) REACTIONS. Ishihara, M. (Tokyo Univ.). Nucl. Phys.; A179: No. 1, 223-40(1972).

The low-lying excited levels of ^{198}Pb and ^{200}Pb have been studied by observing γ-ray and electron spectra in the (p, 4n) and (p, 6n) reactions. Electron angular distributions and γ-ray time distributions were obtained. Decay schemes of yrast levels have been proposed for these nuclei. Half-lives of (9^-) isomers were determined to be 0.54 ± 0.4 μs for ^{200}Pb and 3.7 ± 0.3 μs for ^{198}Pb. The 245 keV $7^- \rightarrow 5^-$ γ-ray in ^{200}Pb and the 198 keV γ-ray in ^{198}Pb were observed to have $T_{1/2} = 50 \pm 10_{1/2}$ns and $60 \pm 15_{1/2}$ns, respectively. Analyses are made on the energy systematics of the first 2^+ states and the hindrance factors of the observed E2 strengths as well as on the relative populations of yrast levels. (auth)

21841 EASY METHOD FOR CALCULATING THE RESONANCE PARAMETERS OF THE ISOBARIC ANALOGUE RESONANCE. Gyarmati, B.; Vertse, T. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Phys.; A182: No. 2, 315-20(1972).

A method using Gamow wave functions is presented for calculating the parameters of the one-level formula for an isobaric analog resonance. As a numerical example the isobaric analog resonances in ^{208}Pb + p were computed. The agreement with the exact solution of the Lane equations is reasonable. (1 figure, 2 tables) (auth)

21842 STROBOSCOPIC DETERMINATION OF THE g FACTOR OF THE 8^+ STATE OF ^{208}Po. Nagamiya, S.; Nomura, T.; Yamazaki, T. (Inst. of Physical and Chemical Research, Saitama, Japan). pp 332-4 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The g factor of the $[h_{9/2}^2(p)p_{1/2}^{-2}(n)]8^+$ isomeric state of ^{208}Po was determined to be 0.902 ± 0.006. The isomeric state of 380 nsec half life was produced in the ^{206}Pb(α,2n) reaction in natural cyclotron beam bursts. The n = 2 stroboscopic resonance was used. The result is in agreement with the g factors of ^{210}Po and ^{209}Bi. (D.L.C.)

21843 QUADRUPOLE MOMENT RATIO OF THE FIRST EXCITED STATES IN ^{192} AND ^{190}Os. Avida, R.; Ben-Zvi, I.; Gilad, P.; (and others). pp 1037-42 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A large quadrupole perturbation was observed in the particle-gamma angular correlations of Coulomb-excited rare earth and transition nuclei (in the A ~ 190 region) following implantation into fused quartz. By comparing the time-integrated attenuation coefficients G_k, the quadrupole moment ratio of the first 2^+ states (initially strongly aligned by coincidence with backscattered projectiles) in ^{192}Os, ^{190}Os was determined as 0.97 ± 0.15. (auth)

21844 ANOMALOUS ORBITAL MAGNETISM OF PROTON DEDUCED FROM THE g-FACTOR OF THE 11^- STATE OF ^{210}Po. Yamazaki, T.; Nomura, T.; Nagamiya, S.; Katou, T. (Inst. of Physical and Chemical Research, Yamatomachi, Japan). pp 1177-9 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The g-factor for the 11^- state in ^{210}Po was measured by the spin rotation method in the reaction ^{208}Pb(α,2n) for 30-MeV α particles. The value obtained was used to deduce an effective g_l-factor for the proton. The anomalous result accounts for part of the anomaly for the magnetic moment of ^{209}Bi. (J.W.R.)

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Refer also to abstracts 20169, 20170, 20982, 21649, 21714, 21732, and 21846.

21845 (AD-731288) X-RAYS FROM FISSION. Semiannual Report, Richard, Patrick; Moore, C. Fred (Texas Univ., Austin). 1 Oct 1971. Contract N00014-67-A-0126-0012. 82p. NTIS.

The report describes the activities pursued during the first six months of the second year contract X-Rays from Fission. The main effort during this part of the contract is to analyze and write-up the research work done using the ^{252}Cf source. This work involved (x-ray, x-ray) coincidence measurements and (x-ray, gamma-ray) coincidence measurements. The results found in the (x-ray, x-ray) work was in some ways unexpected and we have conjectured that the high correlation of self x-ray coincidences occur due to internal conversion cascading. (auth) (USGRDR)

21846 (CEA-N-1484) EVALUATION OF NEUTRON DATA FOR ^{239}Pu. Ribon, Pierre; Le Coq, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1971. 60p. (In French). Dep. NTIS (U. S. Sales Only).

The neutron cross section and associated distributions for ^{239}Pu were evaluated using existing data (KEDAK and UKAEA libraries) as well as the most recent experimental results. Information on the resonance parameters between 7.8 and 660 eV, the fission and total cross sections above 1 keV, the capture/fission cross section ratio between 1 and 30 keV, the inelastic cross section and mean total number of neutrons emitted per fission for all energies is given. The evaluated data are presented with the UKAEA format (DFN 404). (France)

21847 (FEI-227) MEASUREMENT AND EVALUATION OF $\bar{\nu}$ DATA DURING FISSION OF ^{235}U BY FAST NEUTRONS. Prokhorova, L. I.; Bagdasarov, R. Ye.; Kotukhov, I. I.; Nesterov, V. G.; Nurpeisov, B.; Smirenkin, G. N.; Turchin, Yu. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1970. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

The dependence of the average number of prompt neutrons $\bar{\nu}$ emitted during ^{235}U fission on the energy of the bombarding neutrons E_n in the 0 to 1.5 MeV range is measured by the relative method. The value of $\bar{\nu}$ for the spontaneous fission of ^{252}Cf is used as the reference. A neutron detector consisting of 24 ^{3}He counters immersed in a paraffin block is used as the neutron detector. This detector has an efficiency of about 20% and is characterized by an average neutron lifetime of about 50 μs. The data, obtained with an accuracy of 0.8 to 1%, indicate substantial departures from a linear dependence. The recommended curve for $\bar{\nu}$ (E_n) is plotted on the basis of an analysis of combined published data. (JPRS)

21848 (FEI-234) RADIOACTIVE CAPTURE OF NEUTRONS BY A NUCLEUS OF ^{232}Th IN THE ENERGY RANGE 0.01 TO 15 MeV. Davletshin, A. N.; Tolstikov, V. A.; Abramov, A. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 29p. (In Russian). Dep. NTIS (U. S. Sales Only).

A critical examination of experiments was made in the measurement of $\sigma(n,\gamma)$ for ^{232}Th for neutrons with energies exceeding 10 keV. In many cases, the results of the measurements adopted at the present time as reference cross sections are renormalized. A procedure is proposed for averaging the cross sections by taking into account the form of the dependence of the cross section on the energy. From the results of an analysis of the data of various authors, the recommended curve is plotted for $\sigma(n,\gamma)$ of ^{232}Th as a function of the neutron energy in the interval 0.01 to 14.5 MeV. The numerical material used in the renormalizations and averaging is fully given. Also given is the recommended cross section of the radiative capture by ^{232}Th of thermal neutrons. (JPRS)

21849 (IAE-2036) INVESTIGATION OF ^{252}Cf SPONTANEOUS FISSION. Zakharova, V. P.; Korostylev, V. A.; Ryazanov, D. K. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

Assignments of the total kinetic energy of the fission fragments of ^{252}Cf were presented as functions of their mass ratios (R). A double ionization chamber with grid was used for measurement of the energy of the fragments. The spectra of the total kinetic energy of the fragments (E_k), the corresponding symmetrical ($R \approx 1$) and strongly asymmetrical ($R \approx 2$) regions lose the form of the single-hump Gauss distribution. Possible reasons for these phenomena were discussed. (tr-auth)

21850 (ITF-71-41-P) LECTURES ON THE NUCLEAR THEORY. I. Sitenko, A. G.; Tartskovskii, V. K. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 47p. (In Russian). Dep. NTIS (U. S. Sales Only).

The beginning of an enlarged course of lectures given by the authors in the Kiev State University for the students who specialize in the theoretical nuclear physics is given. The lectures present an account of the basic up-to-date concepts on the nuclear structure. The properties of the nucleon interaction at low energies are examined in the present issue. A detailed exploration is made of the dependence of the nuclear forces upon spin, and of a noncentral nature of the nuclear interaction. A phase analysis is made of the N-N scattering cross section, and the two-nucleon states are classified. (auth)

21851 (JINR-P15-6147) STUDY OF THE γ-RAY SPECTRA LEADING TO THE PRODUCTION OF THE SPONTANEOUSLY FISSIONING ISOMERS ^{236}U. Gangrskii, Yu. P.; Dalhsuren, B.; Markov, B. N.; Nagy, T.; Lajtai, A.; Vinnai, I.; Jeki, L.; Kluge, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

In the reactions of radiative capture of thermal neutrons by ^{235}U nuclei, energy spectra of γ-quanta were studied which are connected with spontaneously fissioning isomeric level population in ^{236}U nucleus. The latter decays with $T_{1/2} = 100$ ns. The method of delayed coincidences of γ-rays with fission fragments was used. The reactor (CIPhI, Budapest) served as a neutron source. γ-radiation was detected by means of Ge(Li) detector and the fission fragments were recorded with the gas-scintillation counter. (auth)

21852 (KFK-Ext-4/71-31) MEASUREMENT OF SPECTRA OF DELAYED FISSION NEUTRONS OF ^{235}U, ^{238}U, AND ^{239}Pu WITH PROTON RECOIL PROPORTIONAL COUNTERS. Fieg, Guenter (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1971. 68p. (In German). Dep. NTIS (U. S. Sales Only).

With proton recoil proportional counters delayed fission neutron spectra of different fissile materials were measured within the energy range between about 1300 and 70 keV after irradiation with 14-MeV neutrons. In addition the U-235-probe was irradiated with thermal neutrons. The results for U-235 (thermal fission) are compared with earlier measurements of Harwell, these two different experiments are in good accordance. Moreover, the individual group spectra of the different materials are compared together and discussed. As far as it is known nuclear parameters of some precursors permitting calculated delayed neutron spectra are compared with measured spectra. (auth)

21853 (UCRL-Trans-10579) SEARCH FOR REMOTE TRANSURANIUM ELEMENTS IN IRON-MANGANESE NODULES. Flerov, G. N. Translated for Univ. of California Lawrence Livermore Lab., Livermore, from Acta Phys. Pol.; 38A: No. 4, 595-601 (1970). 11p. Dep. NTIS.

Searches were made for the effects of the fission of remote transuranium elements in iron-manganese nodules taken from the bottom of the South Pacific Ocean. A large number of tracks of fission fragments (from 7 to 120 tracks/mm^2) were detected in minerals of the feldspar group contained in some of these nodules. An analysis shows that spontaneous fission of uranium evidently cannot cause more than 10 to 20% of the observed effects. One of the possible explanations of the observed excess of fission fragment tracks is the assumption of spontaneous fission of remote transuranium elements of terrestrial or cosmic origin which are contained in the nodules. (auth)

21854 LONG-RANGE FRAGMENTS FROM FISSION OF ^{236}U*. Ruddy, Frank H.; Alexander, John M. (State Univ. of New York, Stony Brook). Phys. Rev., C; 5: No. 2, 549-51(Feb 1972).

A search for long-range fission products was made using mica track detectors. Fission of ^{235}U was induced by thermal neutrons, and He gas was employed as the principal stopping material. Limits are reported for the yield of products with range greater than 20 cm He (25°C, 1 atm). The limiting yield values can be reconciled with the ternary-fission studies of Muga only if the light products from ternary fission have $Z \geq 18$. (2 figures) (auth)

21855 MASS-SPECTROMETRIC MEASUREMENTS OF ^{3}H, ^{3}He, AND ^{4}He PRODUCED IN THERMAL-NEUTRON TERNARY FISSION OF ^{235}U: EVIDENCE FOR SHORT-RANGE ^{4}He. Kugler, G.; Clarke, W. B. (McMaster Univ., Hamilton, Ont.). Phys. Rev., C; 5: No. 2, 551-60(Feb 1972).

The mass-spectrometric technique was used to obtain relative

and absolute yields of ^{3}H, ^{3}He, and ^{4}He and energy distributions for ^{3}H and ^{4}He emitted in ternary fission of $^{236}U^{*}$. Evidence was obtained for a short-range (<7.7-MeV) component of ^{4}He. The $^{3}He/^{4}He$ ratio is lower by 2 to 4 orders of magnitude than the values previously found in studies of other fissile nuclides. $^{3}H/^{4}He$ is lower by about a factor of 2 than values obtained for $^{236}U^{*}$ by using other experimental techniques. Energy distributions obtained for long-range ^{3}H and ^{4}He particles are in agreement with results from other experiments. (6 figures, 4 tables) (auth)

21856 PROMPT NEUTRONS FROM ^{236}U FISSION FRAGMENTS. Boldeman, J. W.; Musgrove, A. R. de L.; Walsh, R. L. (Australian Atomic Energy Commission Research Establishment, Sutherland). Aust. J. Phys.; 24: No. 6, 821-33(Dec 1971).

Measurements have been made of prompt neutron emission in the thermal neutron fission of ^{235}U and the mean neutron emission per fragment has been obtained for particular values of the fragment mass and total kinetic energy. A direct neutron counting method was employed and a comparison is made with data from previous experiments of this type. (auth) (Australia)

21857 ENERGIES AND RELATIVE INTENSITIES OF ^{238}Pu, ^{232}U, AND ^{224}Ra α SPECTRA. Soares, J. C.; Ribeiro, J. P.; Goncalves, A.; Braganca Gil, F.; Ferreira, J. G. (Univ., Coimbra). Compt. Rend., Ser. B; 273: No. 22, 985-8(29 Nov 1971). (In French).

The relative intensities of the various groups of α particles emitted from the following nuclei were determined: $^{238}Pu(\alpha_0 = 0.707 \pm 0.002, \alpha_1 = 0.293 \pm 0.002, \alpha_2 = 0.001)$; $^{232}U(\alpha_0 = 0.686 \pm 0.004, \alpha_1 = 0.314 \pm 0.004, \alpha_2 = 0.003_4 \pm 0.000_9)$; $^{224}Ra(\alpha_0 = 0.951 \pm 0.004, \alpha_1 = 0.049 \pm 0.004)$. New values were measured for ^{238}Pu and ^{232}U α_2 groups (5.362 ± 0.001 MeV and 5.139 ± 0.001 MeV, respectively). (France)

21858 INVESTIGATION OF THE INTERNAL CONVERSION ELECTRONS EMITTED DURING $^{228}Ac \rightarrow ^{228}Th$ DECAY. Herment, Micheline; Vieu, Charles (CEN, Grenoble, France. Univ., Grenoble, France. CNRS, Orsay, France). Compt. Rend., Ser. B; 273: No. 23, 1058-61(8 Dec 1971). (In French).

Internal conversion electrons were studied using $\beta\pi\sqrt{2}$ spectrometers and Si(Li) detectors. Transition multipolarities were determined for ^{228}Th. (France)

21859 COHERENT SCATTERING AMPLITUDE OF ^{240}Pu AND ^{242}Pu. Lander, G. H.; Mueller, M. H. (Argonne National Lab., Ill.). Acta Crystallogr., Sect. B; 27: Pt. 11, 2284(1971).

The coherent scattering lengths of ^{240}Pu and ^{242}Pu are 0.35 ± 0.01 and 0.81 ± 0.01 ($\times 10^{-12}$) cm, respectively. Absorption cross sections are 205 ± 10 and ~15 barns, respectively, at 0.08 eV (1.0 Å). (auth)

21860 FISSION CROSS SECTIONS FOR FIVE ISOTOPES OF CURIUM AND ^{249}Cf. Benjamin, R. W.; MacMurdo, K. W.; Spencer, J. D. (Savannah River Lab., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Sci. Eng.; 47: No. 2, 203-8(Feb 1972).

Thermal-neutron fission cross sections and fission resonance integrals were measured for ^{249}Cf and five isotopes of curium with both dual fission chambers and plastic fission track recorders. Measurements were made in the thermal column and core of the SP research reactor. Cross sections were determined through direct comparison with the appropriate ^{235}U fission cross sections, i.e., σ_0^f (effective) = 561.5 b and I^f = 268 b. For the resonance integral measurements, the low-energy cutoff has been adjusted to 0.625 eV. (auth)

21861 ADDITIONAL MEASUREMENTS OF THE RATIO OF THE FISSION CROSS SECTIONS OF ^{239}Pu AND ^{235}U. Poenitz, W. P. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 47: No. 2, 228-30(Feb 1972).

The ratio of the fission cross sections of ^{239}Pu to that of ^{235}U has been measured at 30 keV and from 0.5 to 5.4 MeV. A value of 0.796 ± 0.020 has been obtained at 30 keV. None of the structure reported recently by Savin et al. could be found in the MeV range in the measurements. (auth)

21862 PERTURBED ALPHA–GAMMA ANGULAR CORRELATIONS IN THE DECAY OF ^{241} ^{243}Am. Orre, B.; Falk, F.; Linnfors, A.; Thun, J. E. (Univ. of Uppsala). pp 109-15 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Time-integral and -differential measurements of $\alpha-\gamma$ angular correlations in the decays of ^{241}Am and ^{243}Am were performed. The α particles were detected with a surface-barrier detector while a movable NaI(Tl) detector was used for the γ rays. The recoil ions were implanted in various metallic elements as well as other materials. A parallel magnetic field was found to change the correlations only in the case of ferromagnetic elements. (J.W.R.)

21863 ALPHA–GAMMA LINEAR POLARIZATION MEASUREMENTS IN THE DECAY OF $^{223}Ra \rightarrow ^{219}Rn$. Canty, M. J.; Krien, K. (Univ., Bonn.). pp 115-19 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Alpha–gamma linear polarizations of the 269 and 445 keV transitions in the α decay of ^{223}Ra were measured. Some conclusions regarding the ground-state spin of ^{223}Ra were drawn from the results. (J.W.R.)

21864 FISSION COMPONENTS IN ^{236}U NEUTRON RESONANCES. Theobald, J. P. (EURATOM, Geel, Belgium); Wartena, J. A.; Weigmann, H.; Poortsmans, F. Nucl. Phys.; A181: No. 2, 639-44(1972).

Fission widths of ^{236}U neutron resonances were determined in the energy range between 5.45 and 415 eV. They show small variations in this range and have an average of $\langle \Gamma_f \rangle$ = 0.35 MeV. Consequences of these results on fission barrier parameters of ^{237}U are discussed. (auth)

21865 EXCITATION OF 0^{+} STATES IN TWO-PARTICLE TRANSFER REACTIONS. Abdulvagabova, S. K.; Ivanova, S. P.; Pyatov, N. I; (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 38B: No. 4, 215-17(21 Feb 1972).

The spectroscopic factors for the two-particle transitions to the ground and excited 0^{+} states are studied in the model with pairing, quadrupole, and spin–quadrupole forces. A qualitative explanation of the observed cross-section ratios in the actinide nuclei is obtained. (auth)

21866 INVESTIGATION OF γ-RAY EMISSION PRECEDING ISOMERIC FISSION OF ^{236}U. Browne, J. C.; Bowman, C. D. (Univ. of California, Livermore). Phys. Rev. Lett.; 28: No. 10, 617-20(Mar 1972).

Measurements were made to detect γ rays preceding isomeric fission in ^{236}U induced by eV-range neutrons captured in ^{235}U. A limit of $\leq 6 \times 10^{-5}$ was placed on the ratio of the rate of isomeric fission events with prefission γ rays to the rate for prompt fission events. This experiment provides direct evidence that the penetration of the outer barrier is much greater than that of the inner barrier for 3^{-} and 4^{-} states in ^{236}U. (auth)

21867 EXCITATION OF SPONTANEOUSLY FISSIONING ISOMER STATES ^{239}Pu AND ^{243}Am IN INELASTIC SCATTERING OF γ QUANTA. Gangrskii, Yu. P.; Markov, B. N.; Kharisov, I. F.; Tsipenyuk, Yu. M. (Joint Inst. for Nuclear Research, Dubna, USSR. Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 6, 249-51(20 Sep 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 6, 370-2(20 Sep 1971).

Photon inelastic scattering by ^{239}Pu and ^{243}Am with excitation of fission isomers was studied at γ endpoint energies from 7 to 11 MeV. A fission isomer with a half-life of 8 msec was found for ^{239}Pu and one with a half-life of 6.9 msec was found for ^{243}Am. A multifilament spark counter was used as a fission fragment detector. The fragment yield was measured as a function of the γ endpoint energy. The data indicate that the population of the isomeric states proceeds predominantly from levels above the fission barrier. (J.W.R.)

21868 NEW EVALUATION OF NUCLEAR DATA FOR ^{235}U. Schatz, B. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 17: No. 1, 33-4(Jan 1972). (In German).

Deviations of the newer nuclear data on ^{235}U from the somewhat older data form the basis of a brief discussion of values taken from the British, American, and German data collections. Certain limitations are recommended when employing experimental results of specified sources. (32 references) (TSS)

21869 USE OF THE ELECTROMIGRATION METHOD TO INVESTIGATE THE YIELDS OF CERTAIN RARE EARTH ELEMENTS IN THE REACTIONS $U(^{12}C,f)$, $U(^{22}Ne,f)$, AND $U(^{40}Ar,f)$. Gvozdev, B. A.; Gritchenko, Z. G.; Makarova, T. P.; Oganesyan, Yu. Ts.; Stepanov, A. V. Sov. Radiochem. (Engl. Transl.); 13: No. 3, 437-44(May-Jun 1971).

Translated from Radiokhimiya; 13: No. 3, 421-9(May-Jun 1971).

A method was developed for electromigration separation of

rare earth fragments from the fission of uranium by heavy ions. The relative yields of the isotopes of La, Ce, Pr, Nd, Pm, Sm, Eu, and Gd were measured in the fission of uranium by carbon, neon, and argon ions. The curves of mass distribution of isotopes of the rare earth elements in the fission of uranium by heavy ions were constructed. (auth)

21870 FORMATION, PRODUCTION, AND USES OF TRANSURANIUM NUCLIDES. Seelmann-Eggebert, W. (Kernforschungszentrum , Karlsruhe, Ger.). Kerntech. Atomprax.; 13: No. 10, 425-30(Oct 1971). (In German and English).

In a short general review, existence of transuranium elements in the universe, their formation by multiple neutron capture in neutron flashes, by successive neutron capture in a nuclear reactor and by heavy ion reactions are dealt with. The present state of knowledge about the transuranium elements and the different ways of production are shown on the chart of the nuclides. The nuclides ^{252}Cf, ^{244}Cm and ^{238}Pu, which can be used as heat or neutron sources, are discussed in more detail. (auth)

21871 PHYSICS AND CHEMISTRY WITH HEAVY IONS. I. NUCLEAR PHYSICS. Fricke, B. (Northwestern Univ., Evanston, Ill.); Scheid, W. Kerntech. Atomprax.; 13: No. 10, 431-7 (Oct 1971). (In German and English).

This paper explains the nuclear physical considerations which led to the postulation of the existence of super-heavy nuclei in the neighborhood of the proton numbers 114 and 164, and discusses four possibilities for producing such nuclei with the aid of a heavy ion accelerator. Merely the demonstration of the actual existence of such nuclei would provide a large volume of nuclear physical information and would prove or disprove a number of theoretical postulations. This would open for nuclear physics a wide range of new possibilities, of which only the study of the Coulomb barrier, Coulomb excitation, and a few aspects of nuclear fission are briefly mentioned. (auth)

21872 INVESTIGATION OF THE RADIATIVE CAPTURE OF FAST NEUTRONS PRODUCING SPONTANEOUSLY DECAYING ISOMERS ^{242}Am AND ^{244}Am. Nagy, T.; Belov, A. G.; Gangrskii, Yu. P.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Acad. Sci. Hung.; 30: No. 3, 293-300(1971). (In Russian).

The ratios of the production cross sections of the spontaneously decaying isomers ^{242}Am and ^{244}Am and of the prompt fissions taking place during the reactions $^{241}Am + n$ and $^{243}Am + n$ were measured as functions of neutron energy up to 16 MeV. The measurements show that these ratios are of the same order of magnitude for both isomers and decrease monotonically with the increase of neutron energy. The results obtained can be interpreted on the basis of the double-hump potential barrier model. (6 figures) (auth)

21873 SUPERHEAVY ELEMENTS IN NATURE? Cherry, R. D.; Ahrens, L. H. Comments Earth Sci., Geophys.; 2 No. 3, 77-85(Oct-Nov 1971).

A general discussion of the possibilities of naturally occurring superheavy elements is given. The theoretical evidence for the existence of closed shells in nuclides with $A \sim 294$ is good, but the theoretical half-life predictions do not enable one to assert with confidence that some of these nuclides must be long-lived on a time scale of 10^8 years. The chemical and decay properties of superheavy elements are discussed; identification will necessitate chemical separation. Detection of high-multiplicity neutron coincidences during spontaneous fission would provide strong evidence for the existence of a superheavy; another possibility is the occurrence of anomalies in spontaneous fission daughter products. Solid experimental evidence has been found that superheavy nuclei existed at some stage in the history of the solar system. Positive results have been reported for W synchrotron targets, lead glass, meteorites (anomalous Xe ratios), astrophysical and cosmic-ray data, and various other sources; however, none of these can be regarded as entirely convincing. It is concluded that the most likely candidate for survival is Z = 108. This preference is based primarily on pointers from experimental evidence from natural samples; it is tenable only if the element is volatile and the beta-stability line is slightly different from that often accepted. (38 references) (R.W.R.)

Nuclear Theory

Refer also to abstracts 20392, 21658, 21780, 21850, 22155, and 22156.

21874 (BNL-16480) TABLE OF ATTENUATION COEFFICIENTS FOR ANGULAR DISTRIBUTION OF GAMMA RAYS FROM PARTIALLY ALIGNED NUCLEI. der Mateosian, E.; Sunyar, A. W. (Brookhaven National Lab., Upton, N. Y.). 3 Jan 1972. 15p. Dep. NTIS.

A set of attenuation coefficients have been calculated to be used in the interpretation of angular distributions of γ radiations from partially aligned nuclei. (auth)

21875 (COO-3235-9) VALIDITY OF DWBA FOR DEUTERON STRIPPING. I. MITRA THREE-BODY MODEL. Bouldin, D. P.; Levin, F. S. (Brown Univ., Providence, R. I. Dept. of Physics). [1971]. 44p. Dep. NTIS.

Mitra's three-body, separable potential model of deuteron stripping is re-examined and new results are derived. It is shown that because a separable interaction is a one-dimensional projection operator, a DWBA amplitude can be formulated which is identical to the exact stripping amplitude. This result validates the general prescription of DWBA to retain an unpolarized or "unstretched" deuteron internal wave function, or equivalently, validates the replacement in the DWBA of a three-body deuteron wave function by a product of two-body wave functions, one the ground state and the other a center-of-mass wave function. The center-of-mass wave function is not that for elastic (deuteron) scattering, although it does obey an equation with a complex potential well which on the energy shell reduces to the complex potential well for elastic scattering. These results are in accord with the recent results of Johnson and co-workers who find that inclusion of continuum states via their adiabatic method as a means of improving the usual DWBA wave function leads to a one-body equation in which the optical potential is not that for elastic scattering. The work of Reiner and Jaffe is used to show that the elastic deuteron wave function used in the conventional DWBA is a good approximation to the new DWBA center-of-mass function for the three-body model, thus justifying use of the conventional DWBA. (auth)

21876 (IJS-P-269) STUDY OF PAIRING VIBRATIONAL STATES IN NUCLEI WITH GENERATOR COORDINATE METHOD. Justin, Desan (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Jul 1971. 54p. (In Serbo-Croatian). Dep. NTIS (U. S. Sales Only).

An approach of the generator coordinate method was tested which is convenient for the description of collective states. Instead of a subspace of many parametric generator functions a subspace of single-parametric generator functions was introduced. It was shown that this subspace can be truncated in the orthogonalization procedure to a smaller subspace still containing relevant information about low lying states. The proposed procedure offers a good description of low lying states in a subspace of rather small dimension and is therefore convenient for the calculations in which exact diagonalization of the Hamiltonian is not possible, because of the large dimension of the complete subspace. This procedure was used for the description of pairing vibrations in the seniority zero subspace. Calculations for a three-level system, as well as for nuclei, show that this procedure is reliable in the whole range of interaction strength, unlike the other approximative methods. This proved important because it is not possible to predict reliably whether the nucleus is superconducting or nonsuperconducting. N-projected BCS functions were used to describe pairing vibrations. Calculations with such functions is rather tedius and therefore simpler types of functions were also studied. A new method of approximate projection of the number of nucleons from the BCS function was introduced. The subspace of approximate projected BCS functions proved convenient for the description of pairing vibrations. In the description of the pairing vibrations restriction was made to the seniority zero subspace. The results can be therefore interpreted also as a test of how well the pairing vibrations can be calculated within such a subspace. The calculated energies and transition probabilities are in qualitative agreement with experiment. To achieve this, a more realistic approximation for the two-nucleon transfer operator had to be used. A further study in this direction would be useful (DWBA). Some improvements might be expected from a more realistic approximation for the Hamiltonian. For a more quantitative description of experimental results it would be necessary to study coupling with other degrees of freedom (quadrupole vibrations, seniority two states). This might split pairing vibrational levels and redistribute the transition strength. (auth)

21877 (ITF-71-78-P) ON SOME POSSIBILITIES TO SOLVE THREE-NUCLEON PROBLEM WITH POSITIVE ENERGY. Belyaev, V. B.; Efimov, V. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 26p. (In Russian). Dep. NTIS (U. S. Sales Only).

The attempts and possibilities for solving the nuclear three-body problem at a total positive energy are reviewed. (auth)

21878 (ITF-71-99-E) INTEGRAL EQUATIONS FOR FOUR IDENTICAL PARTICLES. Kharchenko, V. F.; Kuzmichev, V. E. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 30p. Dep. NTIS (U. S. Sales Only).

Based on the Faddeev–Yacubovsky approach, a set of integral equations for four particles is obtained in the simplest case when all the particles are identical and spinless (bosons). This set consists of two equations. The simplification of the equations obtained with the use of a separable two-body potential is considered. The subsequent separable representation of the scattering amplitudes for subsystems reduces the equations to single-variable ones. (auth)

21879 (JINR-P4-6151) TERNARY FISSION IN COMPOUND NUCLEUS REACTIONS. Kalinkin, B. N.; Permyakov, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Interpretation of ternary fission is suggested. The model makes it possible to explain the cross-section value, its dependence on energy, and preferableness of fission into the fragments of comparable mass. (auth)

21880 (JINR-P4-6152) DYNAMIC DEFORMATION EFFECTS IN THE COMPOUND NUCLEUS REACTIONS. Kalinkin, B. N.; Permyakov, B. P.; Shilov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The effective radius for strong interactions of two nuclei obtained in analyzing the differential cross sections of an elastic scattering is studied. (auth)

21881 (WCAP-7363) ETOT: A FORTRAN IV PROGRAM TO PROCESS DATA FROM THE ENDF/B FILE TO THERMAL LIBRARY FORMAT. Beard, Charles L.; Dannels, Robert A. (Westinghouse Electric Corp., Pittsburgh, Pa.). Mar 1971. 69p. (ENDF-146). Dep. NTIS.

ETOT is a digital computer program which processes basic nuclear data in the ENDF/B format and produces library data in thermal library format. ETOT is written entirely in ASA standard FORTRAN and is designed to be computer independent. Along with printed results, the output includes punched cards in the format appropriate to the desired library. (auth)

21882 COMPLEX EIGENVALUES OF A COUPLED-CHANNELS MODEL. Koch, Justus H. (Los Alamos Scientific Lab., N. Mex.); Sternheim, Morton M.; Walker, James F. Phys. Rev., C; 5: No. 2, 381-3(Feb 1972).

It has been found that the usual optical model predicts the existence of "inner states" localized within the absorptive region. They cause highly nonlinear effects in the familiar eigenstates. Analogous results are obtained for a coupled-channels model. (1 figure) (auth)

21883 PERTURBATION THEORY IN THREE-PARTICLE SCATTERING. Kowalski, K. L.; Pieper, S. C. (Case Western Reserve Univ., Cleveland). Phys. Rev., C; 5: No. 2, 324-7(Feb 1972).

Two distinct types of perturbation theories for three-particle scattering which are based upon the decomposition of the two-particle transition operators into dominant and weak parts are investigated. The relationship of these two techniques and their usefulness in practical calculations are discussed. (auth)

21884 MATRIX ELEMENTS OF PENETRATION IN SINGLE-PARTICLE POTENTIALS. Voikhanskii, M. E.; Grigor'ev, V. N.; Listengarten, M. A.; Feresin, A. P. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 4, 847-54(Apr 1971). (In Russian).

Gamma transitions which are forbidden by asymptotic quantum numbers are examined. Formulas are presented for computing intranuclear conversion matrix elements, and the results of using this theoretical approach are compared with experimental data with satisfactory agreement. (K.S.W.)

21885 CRITICAL CHARGE IN COLLISIONS OF NUCLEI. Popov, V. S.; Rozhdestvenskaya, T. I. JETP Lett. (USSR) (Engl. Transl.); 14: No. 4, 177-80(20 Aug 1971).

[28]Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 4, 267-70(20 Aug 1971).

The critical charge Z_c is defined as that value of the nuclear charge at which the energy of the electronic ground state reaches the limit of the lower continuum. For the isolated nucleus the calculated critical charge is $Z_c = 170$. The possibility of producing supercritical nuclei in collisions of heavy atoms is examined. (L.T.W.)

21886 MICROSCOPIC THEORY OF TWO-PHONON QUADRUPOLE-OCTUPOLE VIBRATIONS IN SHPERICAL NUCLEI. Raduta, A. A. (Joint Inst. for Nuclear Research, Dubna, Moscow. ICTP, Trieste, Italy); Sandulescu, A. Nucl. Phys.; A181: No. 1, 153-73(1972).

A microscopic description is given for the states 1^-, 2^-, 3^-, 4^-, 5^- by a HRPA treatment of the conventional shell-model Hamiltonian with pairing, quadrupole and octupole forces. These states are explained by the influence of the anharmonic terms, including the quadrupole and octupole branches, appearing in the motion equations of quadrupole and octupole two-quasiparticle operators, on the two-quadrupole-octupole RPA phonon states. The spectral decomposition procedure is used to treat the anharmonic terms. Expressions are derived for the quintet splitting and for the relevant B(E3) values. Also, the HRPA corrections to the RPA 2^+ and 3^- energies are evaluated. The theory is applied to the single-open-shell nucleus ^{114}Sn and compared with the previous calculations. (auth)

21887 TENSORIAL EXPANSION OF AN INTERACTION INTO HYPERSPHERICAL HARMONICS. Fabre de la Ripelle, M. Compt. Rend., Ser. A; 273: No. 21, 1007-9(22 Nov 1971). (In French).

A method is presented for expanding any noncentral tensorial potential into hyperspherical harmonics. This method is applied to the expansion of a tensorial nuclear force. (France)

21888 E2 TRANSITION PROBABILITIES IN EVEN NUCLEI. Rajput, M. S.; Augusthy, A. (Aligarh Muslim Univ., India). Indian J. Phys.; 44: No. 3, 198-203(Mar 1970).

E_2 transition probabilities for $2^+ \rightarrow 0^+$ ground state transitions of even–even deformed nuclei have been calculated using Davydov and Rostovsky (DR) estimates. The predictions of this model have been compared with the experimental data. From this comparison, it has been found that the DR estimates are closer to the experimental rates. The variations of the ratios $[B(E_2)exp/B(E_2)DR]$ and $[B(E_2)exp./B(E_2)SP.]$ with nonaxiality parameter "γ_0" of Davydov and Filippov theory which is a measure of the degree of departure from the axial symmetry have been studied. (auth)

21889 NON-CENTRAL EFFECTIVE FORCES BETWEEN NUCLEONS IN NUCLEAR MATTER. Sprung, D. W. L. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A182: No. 1, 97-111(1972).

The noncentral components of the Sprung–Banerjee effective interaction are derived from a nuclear matter calculation based on the Reid potential. The strength of the spin-orbit force is about 10% smaller than empirical values used in recent Hartree–Fock calculations using density-dependent interactions. (auth)

21890 ELASTIC SCATTERING BETWEEN COMPOSITE NUCLEI AT HIGH ENERGY. Kanada, Hiroyuki (Nagoya Univ., Japan); Sakai, Kenji; Yasuno, Masaru. Progr. Theor. Phys. (Kyoto); 46: No. 4, 1071-87(Oct 1971).

Elastic scattering between composite nuclei at high energy is studied on the basis of Glauber's multiple scattering formalism. As the mass number increases, the contribution from various multiple scatterings becomes appreciable and the terms corresponding to particular interaction processes play dominant roles at large angles in differential cross section. In the case of deuteron–deuteron scattering the comparison with experiment is done. The ratio of the real part to the imaginary one of scattering amplitude is considered. Comments are given on the effect of nuclear inner correlation, and it is shown that its effect is less important even at large momentum transfer. (auth)

21891 QUADRUPLING AND PAIRING IN THE SHELL MODEL. Eichler, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin. Freie Univ., Berlin); Yamamura, M. Nucl. Phys.; A182: No. 1, 33-53(1972).

A system of Z protons and N neutrons (Z + N = even) moving in nondegenerate j-levels is treated for an isoscalar T = 1 pairing interaction and an effective four-body force. A classification scheme is introduced in which the basis states are explicitly classified with respect to the number of quadruples (systems of two pairs with J = 0, T = 1 coupled to T = 0) and the number of T = 1 pairs in each of the levels. For the particular case of two j-levels the system has been solved exactly. The two-particle transfer, the four-particle transfer and the four-particle scattering exhibit a phase transition between a normal and a superfluid phase. The superfluid phase is shown to consist mainly of quadruples, not pairs, even for a pure isoscalar pairing force. A quadrupling seniority scheme is discussed in close analogy to the pairing seniority scheme. (auth)

21892 TRANSFER REACTIONS BETWEEN HEAVY IONS. Broglia, Ricardo A.; Winther, Aage (Univ. of Copenhagen). Nucl. Phys.; A182: No. 1, 112-30(1972).

The theory of transfer reactions between heavy ions is formulated in a semi-classical approximation in terms of coupled differential equations in time which include the effects of excitation in entrance and exit channel and the nonorthogonality of the wave functions. The main effects of the exchange of energy, mass, and charge are taken into account. (auth)

21893 EFFECT OF THE SPIN-DEPENDENT FORCE ON THE MOMENT OF INERTIA. Kammuri, T. (Niels Bohr Inst., Copenhagen); Kusuno, S. Phys. Lett.; 38B: No. 1, 5-7(10 Jan 1972).

A formula for the moment of inertia modified by the spin-dependent force is given. It is compared with the usual cranking-model formula in the deformed even-even rare-earth nuclei. The agreement with the experimental moment of inertia is substantially improved by the spin-quadrupole effect. (auth)

21894 RESIDUAL INTERACTIONS OF PAIRING AND QUADRUPOLE-PAIRING TYPE. Stepien-Rudzka, W. (Inst. of Nuclear Research, Warsaw). Acta Phys. Pol.; B2: No. 6, 723-9(Nov-Dec 1971).

The residual two-body interaction is investigated. A new term is added to the standard pairing force, and its influence on the single particle excitation spectra in heavy nuclei (transuranic region) is examined with special attention given to the behavior of the so-called "energy gap", a typical parameter in spectra of even-even nuclei. (auth)

21895 GENERATOR COORDINATE APPROACH FOR THE DESCRIPTION OF PAIRING VIBRATIONS IN THE SENIORITY-ZERO SPACE. Justin, D.; Mihailovic, M. V.; Rosina, M. (Univ. of Ljubljana, Yugoslavia). Nucl. Phys.; A182: No. 1, 54-68 (1972).

The application of the generator coordinate method is extended to non-harmonic systems. The many-dimensional Hill–Wheeler integral equation is reduced to a one-dimensional integral equation by expressing all independent parameters in the generator function by a single parameter. It is shown that the subspace spanned by a proper single-parameter family is the same as that spanned by the many-parametric family of generator functions. The subspace of the seniority-zero states relevant to the description of pairing vibrational states is spanned by the N-projected BCS function depending on the gap parameter. It is shown on a schematic three-level system that a good description of energies and two-body transfer amplitudes of the pairing vibrational states can be obtained in a subspace much smaller than the seniority-zero subspace. Having a method working equally well for superconducting nuclei, non-superconducting nuclei and in the intermediate region, how well the seniority-zero subspace is suitable for the description of low-lying 0^+ states in Pb and Sn isotopes was tested. It seems that only a qualitative description is possible. (auth)

21896 FOUNDATION OF THE VMI MODELS FOR THE GROUND STATE COLLECTIVE MODES OF DOUBLY EVEN NUCLEI. da Providencia, J.; Urbano, J. N. (Univ., Coimbra). Nucl. Phys.; A182: No. 1, 174-82(1972).

A justification is proposed for the well-known VMI models of Diamond et al. and Mariscotti et al. based upon the method of generator coordinates. On discussing their relative domains of application, it is concluded that, contrary to the general trend, the stretching model is to be preferred over the region of good vibrators, a result which seems to be confirmed by the scarce experimental data. (auth)

21897 QUARTET HARTREE–FOCK MODEL FOR THE NUCLEAR sd SHELL. MacDonald, N.; Morrison, I.; Watt, A. (Univ. of Glasgow). Nucl. Phys.; A182: No. 1, 183-92(1972).

Approximate intrinsic states for nuclei in the sd shell having $N = Z = 2n$, where n is an integer from 1 to 5, are formed from products of 2 to 5 basic units or quartets. These quartets are the lowest Hartree–Fock intrinsic states for ^{20}Ne (four particles) and for ^{36}Ar (four holes). From the energies of the approximate intrinsic states one can gain some understanding of the sequence of energies of Hartree–Fock intrinsic states of axial, ellipsoidal, three- or four-fold rotational, and cubic symmetry in these nuclei. Some new Hartree–Fock intrinsic states are found using certain of the model intrinsic states as trial states in the Hartree–Fock iteration. In a more detailed analysis of ^{28}Si the effects of choice of two-particle interaction are examined. (auth)

21898 EFFECTIVE QUADRUPOLE CHARGES IN THE LEAD REGION. Astner, G.; Bergstroem, I.; Blomqvist, J.; Fant, B.; Wikstroem, K. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A182: No. 1, 219-24(1972).

The presently available experimental material on effective E2 charges in the lead region is surveyed. Within the experimental accuracy of about 10% no evidence was found for a variation in the effective charge of the $h_{\frac{9}{2}}$ proton orbital as a function of the number of nucleons outside the core. The state dependence of the effective charges for transitions involving different orbitals is well described by a shape-vibrational model of particle-core coupling. There is clear evidence for an isovector polarization charge of about $0.1\ \tau_z e$. (auth)

21899 TIME DEPENDENT POTENTIAL SCATTERING. Starr, Thomas Barry. Madison, Wis.; Univ. of Wisconsin (1971). 167p. University Microfilms Order No. 71-28,368.

Thesis.

A study of the time-dependent aspects of the scattering of well-localized wave packets by several simple cut-off potentials is presented. The wave packets are localized to dimensions comparable to those of the scattering center. Explicit numerical computations and analysis of the detailed time structure of such wave packets have not previously been performed, and are the primary result of this thesis. The wave packets are constructed as a superposition of the continuum eigenstates of each potential. A single physically reasonable momentum distribution is used which describes a spherical, three-dimensional Gaussian wave packet for a free particle. The free particle wave packet is decomposed in terms of a partial wave series so that it may be compared with the potential scattered wave packets. The incoming wave parts of the free and potential scattered integrals are performed exactly and are then placed in closed form for $l = 0, 1, 2$. These results are then used to establish that the dominant contributions to both the free particle incoming and outgoing wave integrals come from a narrow region of the real k-axis near the mean wave packet momentum k_0, provided that certain restrictions are imposed on the observation point and packet parameters. This result is used to develop a very accurate approximation to the potential scattered outgoing wave integral. The approximation is implemented by the use of: 1) asymptotic forms for the spherical Bessel and Hankel functions appearing in the integrand, 2) an approximate expansion of the exact partial wave S-matrix which is very accurate on the interval of the real k-axis from which the dominant contribution to integral comes. The expansion emphasizes nearby singularities of the S-matrix in the complex k-plane. The approximation is used to compute and analyze the time structure of wave packets scattered by isolated resonances, and hard sphere, δ-shell, square well, and square barrier potentials. The time dependent features of the scattering process are exhibited in graphs of the outgoing partial wave packet envelopes, plotted versus time as viewed from a fixed observation radius r. The appearance of exponential decay in a scattered wave packet envelope is traced through the analytical expression for the outgoing wave amplitude to the excitation of resonant states. Difference-frequency beats, modulated by an exponentially decaying amplitude, appear in the scattered wave packet envelope when several resonant states are simultaneously excited with comparable amplitudes. A Debye expansion of the S-matrix permits a unique identification of each multiple internal reflection amplitude with a single peak of the difference-frequency beats. (Diss. Abstr. Int., B)

21900 EFFECTIVE FORCE FOR THE NILSSON MODEL CALCULATIONS OF THE COLLECTIVE NUCLEAR PHENOMENA. Bochnacki, Z. (Joint Inst. for Nuclear Research, Dubna, USSR); Gabrakov, S.; Zielinska-Pfabe, M. Acta Phys. Pol.; B2: No. 6, 793-801(Nov-Dec 1971).

A theoretical estimate of the strength and deformation dependence of the two-body interaction producing the nuclear field is discussed and tested by a RPA calculation. The deformation dependent two-body interaction is used to describe the nonaxial quadrupole vibrational state for the large values of the quadrupole deformation of nuclei. (auth)

21901 STUDY OF SOME MEASURES FOR GROUP SYMMETRY BREAKING IN NUCLEI. Parikh, J. C.; Wong, S. S. M. (Univ. of Rochester, N. Y. Univ. of Toronto). Nucl. Phys.; A182: No. 3, 593-605(1972).

A spectral measure, involving the lowest two moments of the Hamiltonian, is examined to see if it provides on the average an accurate description of the breaking of group symmetry in nuclei. As an example the space symmetry group for a few particles in the 2s–1d shell is considered. The spectral measure is compared with the exact results obtained by diagonalizing the Hamiltonian. It is found that even when there are large admixtures of irreducible representations the spectral measure gives an excellent account of symmetry breaking. Reasons for this are discussed. (auth)

21902 STATISTICAL DESCRIPTION OF DEFORMATION IN EXCITED NUCLEI AND DISAPPEARANCE OF SHELL EFFECTS WITH EXCITATION ENERGY. Moretto, L. G. (Univ. of California, Berkeley). Nucl. Phys.; A182: No. 3, 641-68 (1972).

The deformation of excited nuclei is studied on the basis of the methods of statistical mechanics. The statistical coupling between a system with many internal degrees of freedom and a one-dimensional or multidimensional harmonic oscillator is considered. The relevance of the phase-space volume is discussed in the semiclassical limit. The conclusions are employed to develop a general theory of nuclear deformation for actual nuclei. Calculations for five nuclei are performed on the basis of the Nilsson diagram and of the BCS Hamiltonian. The potential energies of nuclei as a function of deformation are calculated by means of the Strutinsky procedure. The level densities are also calculated directly from single-particle levels and including pairing and its energy dependence. The deformation probability as a function of excitation energy is derived. The nuclear fluctuations in shape are considered and in particular the disappearance of the ground state deformations with increasing excitation energy is described. The calculations account in a natural way for the washing out of shell effects with excitation energy. Applications of the theory are discussed. (auth)

21903 COLLECTIVE 1^+ STATES IN DOUBLY EVEN DEFORMED NUCLEI. Gabrakov, S. I.; Kuliev, A. A.; Pyatov, N. I.; Salamov, D. I.; Schulz, H. (Joint Inst. for Nuclear Research. Dubna, USSR). Nucl. Phys.; A182: No. 3, 625-33(1972).

The properties of collective $I^\pi = 1^+$ (K = 0 and 1) states in doubly even deformed nuclei are investigated in the framework of the Tamm-Dankoff (TDA) and random-phase (RPA) approximations. The Hamiltonian of the model includes the pairing and spin-spin residual interactions. The strength of the latter is found from calculations of magnetic moments in odd-mass nuclei. The calculations of the B(M1, $0^+ \rightarrow 1^+$) values, dipole sum rules and strength functions for M1 transitions show that in rare-earth nuclei the spin-spin correlations concentrate the main strength of M1 transitions in the high-energy region (≈10 MeV) where the coherent 1^+ states may appear (magnetic dipole resonance). (auth)

21904 ^{16}O, ^{40}Ca, AND THE OPTICAL MODEL. Boyd, R. N.; Lombardi, J. C.; Mohan, R.; Arking, R.; Robbins, A. B. (Rutgers-The State Univ., New Brunswick, N. J.). Nucl. Phys.; A182: No. 3, 571-9(1972).

A surface-peaked term has been added to the real-central potential of the optical model resulting in significantly improved fits to proton elastic scattering data from ^{40}Ca and ^{16}O. The real-central potentials are used to determine empirically the mean-square radius of the effective nucleon-nucleon interaction to be 4.64 ± 0.36 fm. (auth)

21905 SEPARABLE EXPANSIONS AND PERTURBATION THEORY FOR THREE-BODY COLLISIONS. Sloan, Ian H. (Univ. of New South Wales, Kensington, Australia). Nucl. Phys.; A182: No. 3, 549-57(1972).

It is known that the partial-wave Faddeev equations can be reduced to a set of coupled one-dimensional integral equations, for any reasonable two-body interactions, by using separable expansions for the two-body t-matrices. In practice, however, it has been difficult to carry this method very far, because the required computing time increases extremely rapidly as the number of terms is increased. A perturbation method for the three-body collision problem is proposed, in which only a few of the most important terms are treated exactly, and the effect of a second group of terms (as many as desired) is treated by perturbation theory. (auth)

21906 SHELL MODEL CALCULATION OF THE $^{16}O + ^{16}O$ POTENTIAL. Yukawa, T. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Lett.; 38B: No. 1, 1-4(10 Jan 1972).

The real part of the $^{16}O + ^{16}O$ potential is calculated from the nucleon-nucleon interaction using a theory which is analogous to that of the generator coordinate method. (auth)

21907 EFFECTIVE INTERACTION AND ISOSPIN SPLITTING. Waghmare, Y. R. (Univ., Heidelberg). Phys. Lett.; 38B: No. 1, 13-14(10 Jan 1972).

In view of the recently observed isospin splitting in giant dipole resonances in nuclei such as ^{11}B an attempt is made to understand such splittings from the view point of effective interactions. From the simple analysis of central forces it is found that while the Wigner and Bartlett exchange mixtures are irrelevant, the Majorana force (A_M) must contribute significantly compared to the Heisenberg force (A_H) and that ($A_M + A_B$) must always be positive. It is also necessary for the effective force to be of long range. (auth)

21908 NEARLY SEPARABLE POTENTIALS. Fiedeldey, H.; Erens, G. (Univ. of South Africa, Pretoria). Phys. Lett.; 38B: No. 1, 15-18(10 Jan 1972).

It is shown that an investigation of the on-shell T-matrix as a function of the strength of the interaction can provide much information on the off-shell behavior of its T-matrix. In particular it is found that a large class of so-called realistic potentials is "nearly separable". (auth)

21909 GENERATOR COORDINATE METHOD FOR NUCLEAR SCATTERING. Tabakin, F. (Univ. of Pittsburgh). Nucl. Phys.; A182: No. 3, 497-521(1972).

A generator coordinate description of nucleus-nucleus scattering is formulated. By imposing proper scattering boundary conditions on the Hill-Wheeler integral equation, one can derive an effective nucleus-nucleus potential directly from the basic two-nucleon Hamiltonian. The effective potential is a rather complicated non-local and energy-dependent operator, but it does incorporate both Pauli exchange effects and the occurrence of nuclear shape, size and orientation changes during the collision. The generator coordinate and resonating group descriptions are compared and it is concluded that they are essentially equivalent. However, the generator coordinate approach is a special truncation which is based on semi-classical ideas of collective nuclear motion. Use of generator coordinates leads one to a set of continuous, coupled Lippmann-Schwinger equations in a biorthogonal basis. As a step toward practical solution of these equations, an effective α-α potential including monopole deformation effects is derived using the independent particle model and a simplified two-nucleon potential. (auth)

21910 K^- NUCLEON INTERACTION IN K MESIC ATOMS. Bardeen, W. A. (CERN, Geneva. Stanford Univ., Calif.); Torigoe, E. Wayne. Phys. Lett.; 38B: No. 3, 135-9(7 Feb 1972).

A study of the nucleon-K^- interaction is made as it pertains to the absorption of K^- mesons in nuclei. Effective interaction strengths are derived which yield good agreement with recent x ray experiments that determine both the strong interaction energy shifts and widths. (auth)

21911 NOTE ON THE ANATOMY OF THE HARTREE-FOCK PROCEDURE. Nair, S. C. K.; Pandya, S. P. (International Centre for Theorectical Physics, Trieste, Italy). Nucl. Phys.; A181: No. 2, 660-68(1972).

The question of the constraints imposed on the nuclear Hamiltonian to obtain a good overlap between the Hartree-Fock and exact shell-model solutions and the convergence of the iterative procedure of solving Hartree-Fock equations are re-examined; a simple model space and a model Hamiltonian which permit more extensive investigations than the one used by Harvey and Jensen are used. The role of an intruder state in the convergence as demonstrated by Harvey and Jensen is confirmed, and the dependence on the energy of this state is studied in detail. (auth)

21912 CORRECTIONS TO THE GAUSSIAN OVERLAP APPROXIMATION. Alves, Antonio J.; Silva, Elisa M. (Univ., Coimbra). Nucl. Phys.; A181: No. 2, 669-72(1972).

It is observed that the validity of the Gaussian overlap approximation does not imply the validity of the harmonic approximation. A simple procedure for converting the integral eigenvalue equation of the generator-coordinate method into a differential eigenvalue equation is presented. The method proposed assumes the validity of the Gaussian overlap approximation, but it may be applied to highly anharmonic situations. A test of the method is made with the Lipkin model. (auth)

21913 EFFECTS OF NON-ORTHOGONALITY AND VIRTUAL EXCITATIONS IN DIRECT REACTIONS. I. Goldfarb, L. J. B.; Takeuchi, K. (Univ. of Manchester, Eng.). Nucl. Phys.; A181: No. 2, 609-38(1972).

A derivation is given of the transition amplitude for a process involving the transfer of a single nucleon, as, for example, a (d,p) process, with specific attention given to the fact that the bound-state functions in the entrance and exit channels are not orthogonal. The solution is first presented in terms of a set of coupled-channel equations. These are subsequently converted into integral equations, which are iterated to first and second order. Allowance is made of the effects of virtual excitations in the entrance channel and virtual excitations and de-excitations in the exit channel. Preliminary calculations for a variety of (d,p) reactions suggest that the nonorthogonality effects are of minor importance and that they are most insignificant for sub-Coulombic transfer processes. (auth)

21914 INFLUENCE OF SHELL STRUCTURE ON ISOBARIC SPIN SPLITTING. Philpott, R. J. (Florida State Univ., Tallahassee). Nucl. Phys.; A179: No. 1, 113-21(1972).

The nature of the isobaric spin splitting of spectroscopic strength is discussed with the aid of some simple calculations within a shell-model framework. Detailed comparison of observed splittings with model predictions will eventually provide additional clues to the form of the residual interaction. (auth)

21915 PHASE SPACE ANALYSIS OF AN INTERACTING FERMI GAS. Ghosh, S. K. (Saha Inst. of Nuclear Physics, Calcutta); Mukherjee, S.; Chatterjee, A. Phys. Lett.; 38B: No. 4, 203-6(21 Feb 1972).

The concept of momentum anisotropy in the phase space of a system of interacting particles interconnects the momentum deformation with the nuclear interaction energy and deduces an expression for the single-particle level density of the system. The predictions compare favorably with the experimental level-density parameters when RGM interactions are used. (auth)

21916 SHELL-MODEL BOUND STATE CALCULATIONS INCLUDING CONTINUOUS SPECTRA. Cortes, A.; Marty, C. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett.; 38B: No. 4, 211-14(21 Feb 1972).

The factorization method is used to calculate bound-states of nuclei by using single-particle spectra including the continuum. The influence of direct channel–channel coupling and of the position of potential resonances is discussed. A comparison between spectra obtained by different methods is given. (auth)

21917 HIGHER ISOSPIN STATES IN s-d SHELL NUCLEI IN SELF-CONSISTENT MODELS. Satpathy, L.; Goeke, K.; Faessler, Amand (Kernforschungsanlage, Juelich, Ger.). Nucl. Phys.; A179: No. 1, 177-86(1972).

The properties of higher isospin states in doubly even s-d shell nuclei are studied in the projected Hartree–Fock-Bogoliubov (HB) model by treating the ground states of neighboring nuclei as their analogs. In the calculation the realistic yale interaction is used and all the particles are treated alike without assumption of any core. For T = 2 states the calculated excitation energies are compared with the experimental ones. In the case of the experimentally unknown T = 3 and T = 4 states the comparison is made with the prediction of Garvey and Kelson mass formula. In general the agreement is quite satisfactory. The validity of Hartree–Fock (HF) and (HB) models for the description of the ground state bands is discussed. (auth)

21918 PREFORMATION OF α PARTICLES IN HEAVY NUCLEI BY THE ANALYSIS OF n,α REACTIONS. Colli-Milazzo, L.; Marcazzan-Braga, G. M. (Laboratori CISE, Milan. Univ., Milan). Phys. Lett.; 38B: No. 3, 155-8(7 Feb 1972).

It is well known that the emission of α particles under neutron bombardment in nuclei of mass $A \geq 130$ cannot be explained by means of known mechanisms. Statistical evaporation is excluded by the characteristics of the emitted α-spectrum and by the angular distribution, that is always peaked forward. Moreover, cross-section values are also generally much bigger than those foreseen by the evaporation mechanism. This α-emission is generally attributed to some "direct effect", but a good description of this effect has not been given up to now. (auth)

21919 PICKUP–STRIPPING MECHANISM FOR INELASTIC AND QUASI-INELASTIC SCATTERING. Schaeffer, R. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France); Bertsch, G. F. Phys. Lett.; 38B: No. 3, 159-61(7 Feb 1972).

The (^{3}He) reaction can be dominated by the formation of an intermediate alpha-particle cluster. This process accounts for the relatively large cross sections for high spin transfer and the L = 1 shape of some $0^+ \rightarrow 0^+$ transitions. (auth)

21920 ANGULAR DISTRIBUTIONS AND CORRELATIONS OF NUCLEAR RADIATIONS IN NUCLEAR SPECTROSCOPY. Steffen, R. M. (Purdue Univ., Lafayette, Ind.). pp 1-26 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The history of angular correlation studies of nuclear radiations is briefly reviewed. A short introduction into the theory of angular correlation phenomena is presented with emphasis on symmetry considerations. The nuclear properties which may be determined in angular correlation experiments are pointed out. (J.W.R.)

21921 INFLUENCE OF AFTER EFFECTS ON ANGULAR CORRELATION MEASUREMENTS. Thun, J. E. (Univ. of Uppsala). pp 78-97 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The concept of atomic after effects following radioactive decay, and its relation to the hyperfine interactions in general, is discussed. The current state of knowledge concerning after effects on angular correlations is reviewed. Some recent results from alpha, electron capture, and internal conversion decay are presented. Some recent calculations are also discussed as an example of a more quantitative approach to the physical situation. (J.W.R.)

21922 PROBLEMS CONNECTED WITH THE THEORY AND MEASUREMENT OF $\alpha-\gamma$ ANGULAR CORRELATION. Mang, H. J. (Technische Univ., Munich). pp 103-9 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Information on nuclear properties which can be obtained from $\alpha-\gamma$ angular correlation studies is discussed. Some of the problems encountered in these studies are analyzed. A few selected experiments are reviewed. (J.W.R.)

21923 CONVERSION ELECTRON CORRELATIONS IN NUCLEAR STRUCTURE RESEARCH. Gerholm, T. R.; Holmberg, L. (Univ. of Stockholm). pp 120-56 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The theory for angular correlations involving conversion electrons is briefly discussed. The expressions for the analysis of conversion electron correlations are summarized. The experimental techniques are reviewed, with an emphasis on recent developments. Some results from electron correlation experiments are presented. E0, E1, M1 and E2 transitions are treated separately with comments on the evidence for the effects of nuclear penetration and "anomalous" effects. Finally, a few references are given to applications in neighboring fields such as perturbed angular correlations, aftereffects of hole formation, and conversion electrons following nuclear reactions. The main conclusion is that the theory of conversion electron correlations now appears to be well understood and in good agreement with the experiments. The conversion electron correlations therefore present a valuable tool for the study of nuclear structure, regardless of whether nuclear penetration effects show up in the internal conversion process. One may anticipate a shift of emphasis towards studies directly inspired by problems in nuclear structure. The inherent potentialities in the electron correlation method, when applied to conversion electrons following nuclear reactions, represent a challenge for the future. (115 references) (auth)

21924 INFLUENCE OF NUCLEAR STRUCTURE ON THE PARTICLE PARAMETERS FOR ANGULAR CORRELATIONS INVOLVING CONVERSION ELECTRONS AND ON INTERNAL CONVERSION COEFFICIENTS. Band, I. M. (Ioffe Inst. of Physics and Tech., Leningrad); Listengarten, M. A.; Trzhaskovskaya, M. B. pp 176-80 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

It is shown that for high-energy (≈15 MeV) transitions in heavy nuclei, the sensitivity of internal conversion coefficients to penetration effects is small. It is also shown that at the same time, the sensitivity of the particle parameters to penetration effects is high. Internal conversion coefficients and particle parameters were calculated for the K-shell for Z = 62, 92, and 102 using the surface current model and the no-penetration model. The results for the two models are compared. (J.W.R.)

21925 E2–M1 ADMIXTURES IN TRANSITIONS IN DEFORMED AND TRANSITIONAL EVEN–EVEN NUCLEI. Hamilton, J. H. (Vanderbilt Univ., Nashville). pp 181-223 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

A survey of experimental and theoretical studies on E2/M1 mixing ratios in deformed and transitional even-even nuclei is presented. Some recent results are presented and interpreted. Some of the experimental techniques used are described. (133 references) (J.W.R.)

21926 TABLES AND GRAPHS FOR THE ANALYSIS OF (1 TO 3) $\gamma-\gamma$ DIRECTIONAL CORRELATIONS. Ramayya, A. V. (Vanderbilt Univ., Nashville); Hamilton, J. H.; Little, P. E.; Collins, E.; Pinajian, J. J. pp 261-7 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

A set of tables and graphs for the analysis of (1-3) $\gamma-\gamma$ directional correlations was generated for some of the most useful cases of spins and multipolarities. The use of the tables is illustrated. (J.W.R.)

21927 POTENTIAL OF $\gamma-\gamma-\gamma$ TRIPLE DIRECTIONAL CORRELATION STUDIES IN RADIOACTIVE DECAY. Coffman, F. E. (Vanderbilt Univ., Nashville); Hamilton, J. H.; Ramayya, A. V.; Kim, M. U.; Robinson, R. L. pp 270-4 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

An experimental feasibility study of γ triple directional correlations was made to test the usefulness of the method in radioactive decay. Geometry considerations are discussed and the experimental arrangement used is illustrated. The 591.8, 1004.8, and 123.1 keV γ-rays in the decay of ^{154}Eu were used in the study. The results show that the technique has limited applicability in radioactive decay studies. (J.W.R.)

21928 INFLUENCE OF LINEAR POLARIZATION ON THE MEASUREMENT OF CIRCULAR POLARIZED γ-RAYS. Appel, H.; Buerk, K.; Behrens, H. (Univ., Karlsruhe, Ger., Kernforschungszentrums, Karlsruhe, Ger.). pp 319-21 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The sensitivity to linear polarization in measurements on γ circular polarization is discussed. It is noted that in some cases the corrections for linear polarization may be important. (J.W.R.)

21929 SURVEY OF CORRELATION EXPERIMENTS TESTING PARITY AND TIME REVERSAL AND A DISCUSSION OF RECENT PARITY TESTS. Boehm, F. (California Inst. of Tech., Pasadena). pp 339-54 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The principles of correlation studies on parity and time reversal in nuclear interactions are described. Some of the available experimental data are surveyed. Some recent parity tests are discussed in detail. (J.W.R.)

21930 WEAK PARITY-VIOLATING NUCLEON-NUCLEON POTENTIAL. McKellar, B. H. J. (Univ. of Sydney). pp 354-7 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Problems associated with the calculation of the weak meson-nucleon vertex in parity-violating N-N potentials of the π-, 2π-, and ρ-exchange types are discussed. (J.W.R.)

21931 ANGULAR CORRELATION TESTS OF TIME REVERSAL INVARIANCE. Hamilton, D. (Univ. of Sussex, Brighton, Eng.). pp 358-74 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Prospects for the use of angular correlation studies in search for T invariance are surveyed. Both weak interaction and electromagnetic tests are discussed. Among the electromagnetic tests, polarization following β decay, polarization following polarized neutron capture, and Moessbauer measurements are discussed in detail. (J.W.R.)

21932 INTERFERENCE PHENOMENA IN PERTURBED ANGULAR CORRELATIONS (THEORY OF TIME-INDEPENDENT INTERACTIONS). Leisi, H. J. (Swiss Federal Inst. of Tech., Zurich). pp 375-93 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The theory of perturbed angular correlations of time-independent interactions is formulated in such a way as to display explicitly the interference properties of the individual energy levels of the intermediate state. In time-differential angular correlation experiments, interfering energy eigenstates give rise to oscillations whose period is a direct measure of the energy difference of the corresponding levels. Two energy levels that cross as a function of an external magnetic field may produce a resonance in a time-integrated angular correlation experiment, because of interference between the two states. From general symmetry properties of the extranuclear interactions a number of selection rules for interference are derived. Based on these rules and the level structure of the intermediate system in the extranuclear field, general properties of the angular correlation function can be derived without calculation. The method is illustrated by discussing hitherto unobserved effects in angular correlations due to the hyperfine interaction in free atoms and in paramagnetic crystals. Characteristic effects produced by the mixing of states in the vicinity of repulsive energy levels are also discussed. (auth)

21933 ANGULAR CORRELATIONS PERTURBED BY DYNAMIC INTERACTIONS WITH THE ENVIRONMENT. Gabriel, H.; Bosse, J. (Freie Univ., Berlin). pp 394-426 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The theoretical foundations for studies of perturbed angular correlations due to dynamic nucleus-environment interactions are reviewed. The problem is treated in the Liouville representation. A multipole expansion method for treating the subsystem and environment is described. (J.W.R.)

21934 THEORETICAL ASPECTS OF QUADRUPOLE PERTURBATIONS ON TIME-INTEGRATED ANGULAR CORRELATIONS. Alonso, C. T. (Yale Univ., New Haven). pp 426-40 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The possibilities of performing time-integrated experiments on perturbed angular correlations for the purpose of determining static quadrupole moments of short-lived nuclear states are discussed. Some of the problems associated with such measurements are examined. Some recent experiments are reviewed. (J.W.R.)

21935 IMPLANTATION PERTURBED ANGULAR CORRELATION TECHNIQUES IN FERROMAGNETIC AND NON-FERROMAGNETIC MATERIALS. Murnick, D. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 455-86 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Ion implantation techniques relevant to perturbed angular correlation studies are reviewed. Topics discussed include implantation methods, range straggling, radiation damage and lattice location of implanted ions, reaction recoil implantation, and single crystal quadrupole moment studies. (J.W.R.)

21936 PERTURBED ANGULAR CORRELATIONS WITH IMPLANTED SOURCES. Deutch, B. I.; Heestand, G. M. (Univ. of Aarhus, Denmark). pp 487-509 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Some of the latest information concerning perturbed angular correlation measurements with sources implanted by isotope separators or Coulomb excitation in various substrates, both ferromagnetic and non-ferromagnetic, is reviewed. Topics discussed include limitations of the method, relaxation processes, and experiments with emitted particles. (J.W.R.)

21937 THEORY OF MAGNETIC MOMENTS: ROTATIONAL NUCLEI. Krumlinde, J. (Lund Inst. of Tech., Sweden). pp 523-30 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The formalism for the description of magnetic moments for low-lying rotational states in deformed nuclei is presented. (J.W.R.)

21938 THEORY OF MAGNETIC DIPOLE MOMENTS OF SPHERICAL AND TRANSITIONAL NUCLEI. Ogaza, S. (Inst. of Nuclear Physics, Krakow). pp 531-6 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The present state of development of the theory of nuclear magnetic moments for spherical and transitional nuclei is discussed. Theoretical predictions are compared with the large body of experimental data. Some of the shortcomings of the current theories are pointed out. (J.W.R.)

21939 SHELL MODEL CALCULATIONS OF MAGNETIC DIPOLE AND ELECTRIC QUADRUPOLE MOMENTS AND γ-RAY MIXING RATIOS. Glaudemans, P. W. M. (Utrecht Univ.); Wildenthal, B. H. pp 537-42 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

Some results of shell model calculations for electromagnetic transition rates and multipole moments in the mass range A = 17 through 40 are discussed. (J.W.R.)

21940 QUADRUPOLE INTERACTIONS AND QUADRUPOLE MOMENTS. Bodenstedt, E. (Univ., Bonn). pp 577-99 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The use of perturbed angular correlations resulting from electric quadrupole interactions as a technique for measuring quadrupole moments of nuclear excited states is discussed. A survey is presented on the present status of studies by time-differential angular correlations and by gamma angular distributions following nuclear reactions. The discussion is limited to internal electric field gradients in metals, crystals with homopolar bonds, ion lattices with paramagnetic or diamagnetic ions, and frozen aqueous solutions. (J.W.R.)

21941 ANGULAR CORRELATIONS IN NUCLEAR DISINTEGRATIONS. Frauenfelder, Hans (Univ. of Illinois, Urbana). pp 618-26 of Angular Correlations in Nuclear Disintegration. /van Krugten, Hans (ed.). Groningen, Netherlands; Wolters-Noordhoff Publishing (1971).

From Conference on angular correlations in nuclear disintegration; Delft, Netherlands (17 Aug 1970).

The present status of the theory of angular correlations and perturbed angular correlations is briefly described. Some of the developments in experimental techniques are surveyed. The future of angular correlation measurements is briefly discussed. (J.W.R.)

21942 POSSIBILITY OF HYPERNUCLEUS PRODUCTION BY HIGH-ENERGY PROTONS AND ELECTRONS. Fetisov, V. N.; Kozlov, M. I.; Lebedev, A. I. (Lebedev Inst. of Physics, Moscow). Phys. Lett.; 38B: No. 3, 129-31(7 Feb 1972).

Methods of hypernucleus production by high-energy particles are suggested. It is shown that the estimated cross sections are measurable with a modern experimental technique. (auth)

21943 HYPERNUCLEI AND THE ΛN INTERACTION. Khrylin B. A. Usp. Fiz. Nauk; 105: No. 2, 185-208(Oct 1971). (In Russian).

This review article presents a brief history of hypernuclei and their relation to $\Lambda-N$ interactions. Experimental work with the latter is hampered by the exceedingly short lifetime of the Λ particle, the formation of which is a rare event. In this connection low-energy $\Lambda-p$ scattering and the theory of $\Lambda-N$ forces are discussed. Experimental work on the hypernucleus bond energy and s-shells is described, including hypernuclear spins, paired $\Lambda-N$ potentials, disturbance of charge independence of $\Lambda-N$ forces, and $\Lambda-N$ tensors. Successive sections are devoted to p-shells of hypernuclei, heavy hypernuclei, excited states of hypernuclei, and the future of physics of this subject. 117 references. (K.S.W.)

21944 ASYMMETRY OF THE MOST ENERGETIC NEUTRONS EMITTED AFTER MUON CAPTURE BY NUCLEI. Longuemare, C.; Piketty, C. A. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Lett.; 38B: No. 3, 125-8(7 Feb 1972).

The asymmetry of the most energetic neutrons emitted after μ capture by nuclei is calculated in a pure shell model to second-order nonrelativistic approximation. For closed-shell nuclei this limiting value is independent of the model used and of the nucleus considered except for a small kinematical dependence. (auth)

21945 PHYSICS AND CHEMISTRY WITH HEAVY IONS. II. PHYSICS OF HEAVY ION SCATTERING. Scheid, W. (Univ., Frankfort am Main); Fricke, B. Kerntech. Atomprax.; 13: No. 10, 438-42(Oct 1971). (In German and English).

This paper discusses the scattering of light and of heavy nuclei on each other. Scattering experiments provide information on the forces arising between the nuclei. This information is important for two groups of problems: firstly, for the relationship between the fission and the fusion of nuclei and, secondly, for the existence of nuclear molecules. Both groups of problems are discussed. (auth)

21946 EXPERIMENTS ON SUB-BARRIER FISSION AND THEIR INTERPRETATION. Theobald, J. P.; Weigmann, H. (EURATOM, Geel, Belgium). Atomkernenergie; 18: No. 3, 229-35(Nov 1971). (In German).

After an introduction into the physics of subthreshold fission recent experiments on this nuclear reaction are described. The results can be understood and interpreted in the frame of V. M. Strutinsky's theory of nuclear deformation. It is shown how quantitative data on the fission barrier, which has according to this theory at least two energy maxima, are obtainable. (auth)

21947 TERNARY FISSION. Brandt, Reinhard (Univ., Marburg, Ger.). Angew. Chem. Int. Ed. Engl.; 10: No. 12, 890-900 (Dec 1971).

In this review paper, ternary fission is defined as the breakup of heavy nuclei into three fragments of approximately equal mass. This relatively new type of nuclear decay has been investigated intensively during the last decade. Muga has studied ternary fission induced by thermal neutrons in uranium. The results of his experiments are discussed in detail. Ternary fission can definitely be observed and studied in the interaction of heavy target elements with 39 MeV alpha particles, 20 GeV protons, and 300–400 MeV argon ions. The ratio of binary-to-binary fission for uranium is approximately 10^{-4}: 100 in the interaction of 39 MeV alpha particles, approximately 0.1: 100 for 20 GeV protons, and 3: 100 for 400 MeV argon ions. A theoretical model for the interpretation of ternary fission, the "cascade model," is described. The paper concludes with a discussion of the possible connection of ternary fission with the production and decay of still undiscovered superheavy elements (Z = 114). (auth)

21948 DISTRIBUTIONS OF THE INITIAL FRAGMENT KINETIC ENERGY IN BINARY AND TERNARY FISSION. Vitta, P. B. (Univ. of Dar es Salaam, Tanzania). Can. J. Phys.; 49: No. 22, 2778-84(15 Nov 1971).

The statistical theory of nuclear fission was originally developed to deal with binary fission. An attempt is made to extend the theory to the case of ternary fission. The probability of a fission mode, given that the nucleus divides into three fragments, is first calculated. Attention is thereafter focused only on the probability distribution of fission modes representing the various possible allocations to the fragment translational motion and internal excitation of the energy available for both translation and excitation. This leads to ternary-fission distributions of the initial kinetic energy (and to complementary distributions of the initial excitation energy) of the fissioning nucleus. Results show that the ternary-fission distributions of the initial kinetic energy are wider with peaks at higher values of kinetic energy than the corresponding binary-fission distributions obtained previously. The (spontaneous-) ternary-fission distributions are peaked at energies of the order of 1 MeV and have full-widths-at-half-maximum (FWHM) in the neighborhood of 3 MeV. These figures are of experimental interest, since they may be used to predict the energy spectra of the fission fragments in ternary fission. (auth)

21949 ISOVECTOR MONOPOLE STRENGTH IN NUCLEI. Auerbach, N. (Tel-Aviv Univ., Israel. Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A182: No. 2, 247-64(1972).

The isovector monopole strength in nuclei is considered. The energy positions and eigenfunctions of the isovector monopole state in several N = Z nuclei are calculated. Some of the properties of the resulting wave functions are discussed. The isovector monopole strength in nuclei with an excess of neutrons is treated next. Expressions for transition probabilities to states with definite isospin T + 1, T, and T – 1 are derived, and estimates of these transitions are given. The importance of the isovector monopole strength in various Coulomb mixing effects is discussed

Some of these are calculated by using the estimates of the transition matrix elements; these effects include isospin mixing in ground states, Coulomb energy shifts, and widths of isobaric analog resonances. (2 figures, 5 tables) (auth)

21950 NUMERICAL APPROACH TO NUCLEAR SHELL-MODEL CALCULATIONS. Whitehead, R. R. (Univ. of Glasgow). Nucl. Phys.; A182: No. 2, 290-300(1972).

An application of the Lanczos algorithm for the matrix eigenproblem to nuclear shell-model calculations is described. The method has many advantages over conventional shell-model techniques, one of the most important being a very much slower growth of computation time with increasing dimensionality of the shell-model basis. (5 figures, 1 table) (auth)

21951 PROJECTED SPECTRA OF HEAVY NEARLY SPHERICAL ODD-A NUCLEI. Feifrlik, V. (Nuclear Research Inst., Rez, Czech.). Nucl. Phys.; A182: No. 2, 301-14(1972).

The energy spectra of heavy odd-A nuclei are investigated using the angular momentum states projected from a BCS internal wave function with small value of deformation parameter. In this way the vibrational motion of spherical odd-mass nuclei can be studied in the framework of the microscopic model. The results presented exhibit some similarity to the phenomenological weak-coupling model of de-Shalit. (1 figure) (auth)

21952 REARRANGEMENT CONTRIBUTION TO SYMMETRY ENERGY AND SINGLE-PARTICLE POTENTIAL. Nemeth, J. (Lorand Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 30: No. 3, 273-81(1971).

The G-matrix elements are determined as a function of the relative momenta for the N = Z nuclear matter and the Z = 0 neutron gas cases. From this the symmetry energy and its rearrangement part and the single-particle potential and its rearrangement part are determined. The saturation condition is fulfilled, and the rearrangement terms turn out to be small. (5 figures) (auth)

21953 METHODS OF CALCULATION OF THERMAL-NEUTRON FISSION CROSS SECTIONS. Mihailescu, Iliana (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 9, 1075-1105(1971). (In Rumanian).

A brief description of the nuclear reaction formalism developed by Lane and Thomas is given first. The experimental data on ^{235}U thermal cross sections are discussed. A method for calculating fission cross sections is described; it depends on the relation between the R and S matrices and uses the inversion of a channel matrix. Analysis of experimental data according to the multilevel formula is treated; and a method for calculating fission cross sections, dependent on the relation of the R and S matrices and using the inversion of a level matrix, is presented. (9 references) (R.W.R.)

21954 NUCLEAR MAGNETIC MOMENTS: SHELL-MODEL INTERPRETATION. Talmi, Igal (Weizmann Inst. of Science, Rehovot, Israel). pp 1133-69 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The role of magnetic moments in the development of the shell model is discussed. The difficulties associated with explaining the deviations of measured moments from the Schmidt values are examined. The concept of effective moments is discussed in detail. (J.W.R.)

21955 TABLE OF CHANGE IN NUCLEAR MEAN SQUARE CHARGE RADIUS. Shenoy, G. K.; Kalvius, G. M. (Argonne National Lab., Ill.). pp 1201-37 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Changes in the nuclear mean squared charge radius with excitation, obtained from Moessbauer and muonic isomer shifts, are tabulated. Some notes concerning particular isotopes are included with the tables. (J.W.R.)

PHYSICS (PLASMA AND THERMONUCLEAR)

21956 (JAERI-M-4564) ANNUAL REPORT OF JAERI THERMONUCLEAR FUSION LABORATORY FOR PERIOD ENDING MARCH 31, 1971. (Japan Atomic Energy Research Inst., Tokyo). Sep 1971. 55p. NTIS (U. S. Sales Only).

Work carried out in the JAERI Thermonuclear Fusion Laboratory for the period of April 1970 to March 1971 is described. During the period, confinement experiments with JFT-1 (a toroidal hexapole device) continued, while construction was started on JFT-2 (a tokamak-type device). Preparations proceeded well on the JFT-2 experiments. In addition to these, descriptions are given on the following: a neutral-particle analyzer designed in Ionized Gas Laboratory, assessment of a tokamak with noncircular cross section, and thermal instability and its control of a nuclear fusion reactor. (auth) (Japan)

Confinement and Heating

Refer also to abstracts 22033 and 22034.

21957 (EUR-CEA-FC-585) EURATOM-CEA ASSOCIATION, PLASMA PHYSICS AND CONTROLLED FUSION DEPARTMENT. Progress Report of the Research Group for 1st of March 1970-31st January 1971. Part 2. Grenoble. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 113p. (In French). Dep. NTIS (U. S. Sales Only).

The scientific results obtained in 1970 by the Plasma Physics and Controlled Fusion Department at Grenoble, consisting of the recently regrouped General Ion Technology Service, are presented. Studies of open configurations involved the interaction between plasmas and hf electromagnetic waves in connection with heating and confinement in magnetic traps: electron cyclotron resonance (Pleiade, Icare, Circe experiments); lower hybrid resonance (Chimere experiment); stabilization of drift instabilities arising from the shearing of the lines of force (Daphnis-Shear experiment) and the hf field (Phaeton experiment). Two toroidal experiments were prepared: the study of form factors in a tokamak and the heating of the ions by transit time magnetic pumping. (France)

21958 (EUR-CEA-FC-616) EXPERIMENTAL INVESTIGATION OF THE STABLE ACCUMULATION OF AN ENERGETIC PLASMA INSIDE A PULSED MAGNETIC BOTTLE CONFIGURATION. Jacquot, Bernard (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1971. 129p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, France.

Energetic electrons and H^+ ions were confined in a mirror machine, in which the effect of the ion loss cone is reduced by electrostatic plugs. The electrostatic potentials are created inside the accelerating and reflecting regions of the Pleiade mirror machine; the accelerating potentials are due to the resonance structure; the reflecting potentials are produced by the magnetic mirror only. This mirror acts on the electrons, a sheath being created by the reflected electrons which subsequently reflects the ions. When the reflecting potentials cannot develop (surrounding wall at earth potential) the ion accumulation is arrested and instabilities occur. Under normal working conditions (10^{-6} to 10^{-4} torr), densities of about $10^{10}/cm^3$ are obtained for energetic electrons and ions (above 1 keV) with ion lifetimes of several msec. The appearance of a cold plasma H_β line at higher pressures is associated with the destruction of the desired operating conditions. (France)

21959 (IPP-6/99) TRANSPORT PROCESSES IN A PLASMA. Dum, C. T. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug 1971. 78p. Dep. NTIS (U. S. Sales Only).

Plasma transport in toroidal magnetic systems is reviewed. The motion of single particles in nonuniform magnetic fields is treated, and a qualitative picture of plasma transport is given. This discussion is followed by the kinetic theory of transport in the weakly collisional (banana), intermediate, and collision-dominated regimes. The latter regime is also treated, using fluid equations. (auth)

21960 (ORO-3778-5) RF HEATING OF FUSION REACTORS. Kristiansen, M.; Hagler, M. O.; Cato, J. E. (Texas Tech Univ., Lubbock. Plasma Lab.). 15 Mar 1971. Contract AT(40-1)-3778. 40p. Dep. NTIS.

An engineering study of rf heating in fusion reactors is described. The frequency range considered is below 100 MHz. Special consideration is given to rf structures located between the reactor wall and the plasma in the main fusion region. Possible arcing problems in this region are discussed, and it is found that they may not be too serious for neutral pressures below 10^{-4} torr. It is proposed to feed the rf through a slanted vacuum port in order to reduce port area and to protect the voltage insulator from radiation and temperature damage. The cooling of an rf coil structure is considered in detail. It is proposed to use a split rf coil composed of heat pipes to carry the heat away. Curves are presented that give the maximum rf on-time for various coil currents, frequencies, and coil sizes before the coil surface reaches melting temperature. Other coupling schemes involving using the vacuum wall as an rf structure or locating a wave launcher in the high field region of a mirror reactor are discussed. For the mirror-reactor case, it is found that this last scheme may be quite attractive since unidirectional couplers can be made and since experimental results indicate that the wave reflection in the severe density and field gradients may not be too severe. This scheme also offers a possible way of launching ion cyclotron waves into very dense plasmas. It is concluded that the engineering problems of fusion-reactor rf heating, albeit formidable, are not impossible. (auth)

21961 PLASMA HEATING WITH VERY SHORT LASER PULSES. Demidov, B. A. (Inst. of Atomic Energy, Moscow); Fanchenko, S. D.; Sholin, G. V.; Zakharov, S. D.; Kriukov, P. G. Phys. Lett.; 38A: No. 5, 303-4(28 Feb 1972).

In experiments with laser-produced plasmas, d-d neutrons were obtained with help of both nanosecond and picosecond laser pulses. The possibility of plasma heating by 10^{-12} to 10^{-14} sec laser pulses is discussed, considering turbulent heating mechanisms. The expected neutron yield and electromagnetic radiation are evaluated. (auth)

21962 PLASMA ENERGY LOSSES IN URAGAN STELLARATOR WITH A HIGH SHEAR. Vishnevetskii, V. N.; Voitenko, D. A.; Volkov, E. D.; (and others) (Kharkov Physical-Technical Inst.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 8, 1320-3(Aug 1971). (In Russian).

Results of research on ohmic heating plasma thermoinsulation in the stellarator are described. Plasma lifetime was measured as dependent on the shear value. It is shown that the results obtained may be explained on the basis of an assumption on development of temperature-drift instabilities. (auth)

21963 APPLICATION OF INTEGRAL TRANSFORMS TO THE ANALYSIS OF CERTAIN CASES OF MAGNETIC FIELDS. Lipinski, Wojciech; Purczynski, Jan; Sikora, Ryszard (Instytut Elektrotechniki, Warsaw). Arch. Elektrotech. (Warsaw); 20: No. 4, 983-94(1971). (In Polish).

Integral Fourier and Bessel transforms are applied to calculation of magnetic fields for a system of conductors. The field is calculated for the whole space. The examples are applicable in plasma physics. (auth)

21964 ELECTRON CYCLOTRON HEATING AS RESONANT DIFFUSION. Eldridge, Owen (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.). Phys. Fluids; 15: No. 4, 676-82(Apr 1972).

The heating of electrons by externally applied microwave fields is treated as a resonant diffusion in velocity space. The diffusion is calculated directly from electron orbits with the microwave fields considered to be small perturbations. The motion of an electron is found to be adiabatic outside resonant zones where the microwave frequency matches the cyclotron frequency. Heating rates are found that are independent of collisional time scales if the correlation length of the external fields is long enough; several wavelengths are required. Finite cyclotron radius effects are included to find the dominant contribution to scattering into the loss cone of a plasma in a mirror field and spatial diffusion rates. The theory is found to agree qualitatively with experiment, but relativistic dynamics must be used for a detailed comparison. (auth)

21965 LIFETIME OF HOT-ION PLASMA IN A MIRROR MACHINE. Stirling, W. L. (Oak Ridge National Lab., Tenn.). Phys. Fluids; 15: No. 4, 688-92(Apr 1972).

A neutral particle analyzer was constructed to investigate the flux of energetic neutral particles emitted from the midplane of

the hot-ion plasma, Burnout V. Energy and momentum analysis reveal that the energy confinement time is limited to 15 μsec by charge exchange of the hot ions on the background flux of Franck–Condon neutral atoms. (auth)

21966 THEORY OF TURBULENT HEATING IN ION ACOUSTIC TURBULENCE. Chiyoda, Katsuji (Electrotechnical Lab., Tanashi, Japan). Phys. Rev. Lett.; 28: No. 10, 588-9(6 Mar 1972).

The energy-conservation relation, in the presence of an ion acoustic wave, is given. An energy-transfer collision frequency is given in terms of the energy spectrum of the ion acoustic wave. It will be shown that this satisfies the relation $\nu_E \simeq (v_0 c_s / v_{ti}^2)\nu_{eff}$, and that electron heating is realized when $v_i \ll c_s \ll v_0 \ll v_e$. (auth)

21967 PLASMA TRAPPED AT THE END OF A SHEET CURRENT IN A DIPOLE FIELD. Hewson-Browne, R. C.; Kendall, P. C. (Univ. of Sheffield, Eng.). J. Atmos. Terrest. Phys.; 34: No. 3, 475-85(Mar 1972).

A two-dimensional model is considered in which a pocket of infinitely conducting plasma, free of magnetic field, is trapped near the end of a current sheet in the presence of a dipole magnetic field. The configuration somewhat resembles that of the Earth's magnetic tail. The problem is solved by the use of complex-variable methods involving conformal transformations. (auth)

Diagnostics

Refer also to abstract 21284.

21968 (EUR-CEA-FC-615) PLASMA DIAGNOSTICS USING A MONOENERGETIC POTASSIUM BEAM. Nicolas, Michel (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sep 1971. 93p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France). Faculte des Sciences.

Measurements of the transparency of a plasma to a neutral beam enabled its density to be deduced. A source providing a beam of single-energy K atoms (0.5 to 2 keV) was developed. After the emergent beam is ionized by oxygen, the K^+ ions having crossed an electrostatic analyzer (resolution 5%) are deflected by a secondary emission assembly and produce photoscintillations. The very short detector response time (0.1 μsec) means that only the K atom transit times in the plasma limit the temporal resolution of the assembly. Measurements of the surface plasma density of the DECA IIB machine and changes in this density with time were carried out with this source–detector assembly. The values obtained are in good agreement with those obtained using microwave interferometry. (France)

21969 (IPPJ-107) ANALYSIS OF MICROWAVE INTERFEROMETER FOR PLASMA DENSITY MEASUREMENT. Kuwahara, Chiyo; Matsuura, Kiyotake; Miyahara, Akira (Nagoya Univ. (Japan). Inst. of Plasma Physics). Mar 1971. 34p. NTIS (U. S. Sales Only).

A phase-shift measurement of a microwave interferometer was analyzed by introducing a "two vector" model. An error due to unbalance and mismatching in the circuit was calculated by considering an attenuation of a transmitted wave and, to verify the theoretical analysis, a simulation experiment was made. (auth) (Japan)

21970 ULTRA HIGH SPEED HOLOGRAPHIC CAMERA. Novaro, Marc (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Compt. Rend., Ser. B; 273: No. 22, 941-3 (29 Nov 1971). (In French).

Ultrahigh-speed holographic cameras may be used as diagnostic instruments and to provide a means of storing the information obtained. Seven holograms were taken, with a 15-nsec exposure time, at 1- or 2-nsec intervals. A resolution of 50 μ was achieved in the reconstructed image. (France)

21971 LASER DIAGNOSTICS OF A POTASSIUM PLASMA USING SELECTIVE EXCITATION SPECTROSCOPY. Measures, R. M.; Rodrigo, A. B. (Univ. of Toronto). Appl. Phys. Lett.; 20: No. 3, 102-4(1 Feb 1972).

A thermally tuned Q-switched ruby laser was used to selectively excite the 6939-Å transition in a potassium plasma. A burst of intensified spontaneous emission at both 6911 and 6939 A was observed. This enhanced emission contains information on the local properties of the plasma as demonstrated by the observed dependence of the signal duration upon the free-electron density. (auth)

21972 HYDRODYNAMIC DRAG ON A SMALL SPHERE IN AN IONIZED GAS. Seymour, E. V. (Shell Pipe Line Corp., Houston, Tex.). J. Appl. Mech.; 38: No. 4, 739-48(Dec 1971).

A theoretical and experimental study was made of the hydrodynamic drag on a small sphere moving relative to a plasma in local thermodynamic equilibrium. The results have application to velocity measurement in ionized gases using the technique of injecting small particles and following their motion as a function of time. The previously available sphere drag results for fluids with properties that vary linearly with temperature are shown to be in error by as much as 40% for an argon plasma at 13,000°K, for example, because large temperature gradients occur in the vicinity of the sphere where fluid properties vary nonlinearly with temperature. A new drag calculation for a sphere Reynolds number of zero was made for an argon plasma, taking into account nonlinear variations of transport properties with temperature. Sphere deflection measurements in an argon plasma were made at Reynolds numbers between 0.3 and 1.5. The interpretation of these measurements in terms of sphere drag is subject to confirmation of the plasma transport properties used in the data reduction, but the difference between the measured drag and the drag calculated for zero Reynolds number appears to be approximately the same as in the classical case for invariant fluid properties. (auth)

21973 MICROWAVE PROBING OF A PLASMA–BEAM DISCHARGE WHEN ACTED UPON BY AN EXTERNAL HIGH-FREQUENCY FIELD. Kirdyashev, K. P.; Zaikina, A. N. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 4, 697-9 (Apr 1971).

Translated from Radiotekh. Elektron.; 16: No. 4, 634-6(Apr 1971).

The passage of a microwave signal in a plasma–beam discharge was investigated at a frequency of 9850 MHz which exceeds the plasma frequency. The oscillator frequency was ~40 MHz. The effects of the high-frequency field on the low-frequency spectrum of the oscillations, on fluctuations of the amplitude, and on the anomalous attenuation of the probing signal were studied. The low-frequency oscillations were found to appear in the form of drift waves. (D.L.C.)

21974 SCATTERING METHOD FOR THE DETERMINATION OF LOW-TEMPERATURE PLASMA PARAMETERS. Pyatnitskii, L. N.; Korobkin, V. V.; Mushinskii, A. A.; Khaustovich, G. P. (State Scientific-Research Power Inst., Moscow). Dokl. Akad. Nauk SSSR; 200: No. 3, 571-4(21 Sep 1971). (In Russian).

A series of important plasma characteristics may be readily obtained from the scattering method. Equations are set forth that contain scattering spectral components, and these equations are employed in connection with the spectrum of scattered radiation from an 18-A arc between tungsten electrodes in argon at atmospheric pressure. (K.S.W.)

21975 MULTI-ELECTRODE PROBE IN A RAREFIED PLASMA. Ponomarev, V. N.; Pogorelyi, M. P.; Zosimova, A. G. (Scientific Research Inst. of Electromechanics, Istra, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 4, 591-5(1971).

Translated from Geomagn. Aeron.; 11: No. 4, 697-702(1971).

The problem of the penetration of ions to the collector of a multi-electrode probe in a rarefied plasma is solved. The effect of the thermal motion of ions, space charge, and of the distortion of the potential field in the screen mesh on the passage of the current is analyzed. (auth)

21976 HYDROGEN LINE RATIOS AS ELECTRON TEMPERATURE INDICATORS IN NONEQUILIBRIUM PLASMAS. Park, Chul (Ames Research Center, Moffett Field, Calif.). J. Quant. Spectrosc. Radiative Transfer; 12: No. 3, 323-70(Mar 1972).

The ratio of intensities of hydrogen Balmer lines $H_\alpha - H_\delta$ is proposed as an indicator of electron temperature in a nonequilibrium plasma. Although different from the equilibrium case, the intensity ratio is a unique function of electron temperature provided that the optical depth is small for the visible lines and the plasma is far out of equilibrium. For such a plasma the intensity ratios of the $H_\alpha - H_\delta$ lines are computed. The results are tabulated in the form of a conversion table between the measured excitation temperature and the true electron temperature. The ranges of applicability of the conversion table are also computed and are presented in separate tables. An example is shown in which particle densities are consistent with the Saha equilibrium condition at the apparent excitation temperature even though the plasma is in nonequilibrium at a different true electron temperature. (auth)

21977 INVESTIGATION OF A XENON PLASMA PRODUCED IN CASCADED ARCS. Hackmann, J.; Michael, H.; Uhlenbusch,

J. (Technische Hochschule, Aachen). Z. Phys.; 250: No. 3, 207-16(1972).

This investigation extends earlier measurements and calculations performed on cascaded arcs burning in the noble gases He, Ne, Ar, and Kr to a xenon discharge. Starting from intensity and line-width measurements of some Xe lines, temperature, and electron density profiles as well as transition probabilities are determined. E–I characteristics evaluated in conjunction with intensity profiles and temperature measurements lead to accurate results for the electrical conductivity. The pressure inside the arc chamber is variable. In a broad region of parameters LTE is established. (auth)

Kinetics (General)

21978 (EUR-CEA-FC-383(Rev.)) COLLISION AND TRANSPORT CROSS-SECTIONS. Drawin, H. W. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan 1967. 188p. Dep. NTIS (U. S. Sales Only).

Cross sections are given for application to plasma diagnostics. Analytical expressions are given for the rate coefficients. Sixty-eight figures are given along with a listing of 331 references. (M.O.W.)

21979 VOPROSY FIZIKI NIZKOTEMPERATURNOI PLAZMY. (Problems of Physics of Low-Temperature Plasma). El'yashevich, M. A. (ed.). Minsk; Izdatel'stvo Nauka i Tekhnika (1970). 680p.

This volume contains 177 papers selected from those delivered at the 2nd All-Union Conference on the Physics of a Low Temperature Plasma. Methods of and problems associated with production of low-temperature plasmas are discussed. Electrical and optical properties of such a plasma, oscillatory phenomena, and the phenomena arising in the magnetic field with a moving plasma are examined. Certain papers are concerned with the interaction of stationary and moving plasmas. Fundamental physical problems of the elementary processes occurring in a low temperature plasma are explored. Additional papers from this conference appeared in the volume "Oscillations and Waves in a Plasma" (1971, 151 pages), for which a separate abstract is included. (K.S.W.)

21980 EFFECT OF THE MEDIUM ON PROPAGATION OF SPACE-CHARGE WAVES IN BOUNDED ELECTRON BEAM. Tolmachev, M. M.; Tseitlin, M. B. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 3, 507-11(Mar 1971).

Translated from Radiotekh. Elektron.; 16: No. 3, 387-91 (Mar 1971).

The propagation of space-charge waves in spatially bounded electron beams in an isotropic plasma is investigated. The propagation constants of waves are determined, depending on the transverse dimensions of the system and the transparency of the medium for electrons. It is shown that limitation of the transverse dimensions of the system has a strong effect on amplification. (auth)

21981 NUMERICAL AND EXPERIMENTAL INVESTIGATIONS OF TRANSIENT PLASMA-FLOW INTERACTIONS WITH STRONG MAGNETIC FIELDS. Sardei, F.; Willeke, K. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Plasma Phys.; 13: No. 11, 999-1006(Nov 1971).

The transient phenomena of shock-produced plasma-flow interactions with a transverse magnetic field were numerically and experimentally investigated. The experiments were performed in a test chamber similar to an MHD power generator. Both computations and experiments show that, for strong interactions, a reflected shock wave is formed in the interaction region and then propagates out of it in the upstream direction. All flow parameters and an x–t diagram of the reflection process were computed and plotted for a region inside and outside the interaction zone. The paths of the primary and reflected shocks were experimentally visualized by means of streak interferometry. Comparison of the numerical x–t plots to the interferograms showed quantitative agreement in all essential phenomena. (auth)

21982 EFFECT OF WALL FRICTION ON THE CURRENT-SHEET SPEED OF A MAGNETICALLY DRIVEN SHOCK TUBE. Chang, C. T. (Danish Atomic Energy Commission Research Establishment, Risoe). Plasma Phys.; 13: No. 11, 1067-73(Nov 1971).

The effect of wall friction on the current-sheet speed is examined by taking some plausible forms of the friction into consideration. The analysis shows that the current sheet always attains a steady state regardless of the types of friction concerned. It further shows that the experimentally observed velocity limitation of the current sheet at discharge conditions of high voltage and low pressure might be attributed to a friction drag varying linearly with the driving current and the current-sheet speed. (auth)

Kinetics (Experimental)

21983 (AD-731803) ARC MOTION AND MODES IN A HOMOPOLAR DEVICE. Final Report, September 1967–August 1969. Noeske, Heinz O. (Systems Research Labs., Inc., Dayton, Ohio). Aug 1971. Contract F33615-67C-1344. 105p. (ARL-71-139). NTIS.

The observed modes and the dynamic behavior of an electric arc in a homopolar device for constant current (100A) and magnetic field (1,500G) are quantitatively dependent on the type of gas (He, Ne, Ar, Xe). The peculiar behavior of the arc for both electrode polarities can be explained as a result of a competition between geometrical flow effects and the Hall effect, with the latter becoming more pronounced with decreasing pressure. The well-known tendency of the cathode spot to move into the retrograde direction at low pressures under the influence of a transverse field seems only of secondary importance. No steady retrograde motion of the arc column was observed. The Hall voltage is used to explain quantitatively the measured dynamic arc voltage as function of pressure. For all gases investigated the measured Hall parameter ($10 > \Omega > 0.4$) is given as a function of pressure and roughly proportional to $1/p$. Also, the arc rotational frequency as function of $1/pM$ (p = gas pressure, M = atomic weight) can be plotted as one curve, which suggests that for lower pressure the main loss is kinetic energy of the rotating gas which has to be replaced by the electromagnetic energy of the rotating arc. In summary, two distinct arc modes for low gas pressures can be defined, depending on electrode polarity: when the center electrode is the cathode, the filamented current-carrying arc moves, together with the gas, at high azimuthal velocity in the amperian direction; when the center electrode is the anode, the discharge becomes diffuse and stationary in regard to the laboratory and pumps the plasma with high speed in the azimuthal amperian direction. (auth) (USGRDR)

21984 (COO-1695-39) PLASMA INSTABILITIES AND WAVES EXCITED BY AN ANISOTROPIC ENERGY DISTRIBUTION PRODUCED BY ELECTRON CYCLOTRON RESONANCE. Quarterly Progress Report No. 18. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). 15 Sep 1971. Contract AT(11-1)-1695. 32p. Dep. NTIS.

The work performed covered three areas, namely: (1) polarization measurements of the free–free bremsstrahlung x rays; (2) optical diagnostics; and (3) microwave calculations. The bremsstrahlung measurements were made to determine the polarization distribution of the free-free bremsstrahlung exiting radially along the midplane as a function of various plasma parameters. Specifically, they are: pressure, magnet current, mirror ratio and off-resonance power, as well as axial displacement of both the heating and observing location. Optical measurements of intensity ratios were made to determine the effects of plasma parameters on neutral and ion temperatures. Finally, further progress on microwave cavity calculations for a warm plasma was made. (auth)

21985 (IPPJ-108) SOME OBSERVATIONS OF A LINEAR SCREW-PINCH DISCHARGE. Hayase, Kiyoshi; Okuda, Takayoshi (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jul 1971. 25p. NTIS (U. S. Sales Only).

Plasma properties in a linear screw-pinch discharge are investigated for the problems of production and stability. This device is characterized in that the half periods of both z and theta currents are as long as 32 μs. Plasma behaviors are observed for different time intervals between starts of z- and theta-pinch discharges. The electron temperature and density measured by laser scattering and interferometry are $\lesssim$10 eV and $\sim 10^{16}$ cm^{-3}, respectively, in a normal pressure region. The sudden collapse of the outer region of the plasma column near the current maximum is observed at certain conditions, and its reason and suppression are considered. The magnetohydrodynamic stability is also investigated, taking into account the distributed current, to explain the mode m = 2 that appears, even within the Kruskal–Shafranov limit in the experiment. The effect of the superposition of the high-frequency z current is examined with a relation to the dynamic stabilization. (auth) (Japan)

21986 (LA-tr-71-79) COLLECTIVE INTERACTIONS AND ELECTRICAL CONDUCTIVITY OF A PLASMA IN STRONG ELEC-

TRICAL FIELDS. Suprunenko, V. A.; Sukhomlin, E. A.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated by Helen Dahlby (Los Alamos Scientific Lab., N. Mex.), from report KHFTI-70-67. 25p. Dep. NTIS.

It is shown that the electrical conductivity of a plasma for small electric fields is a complex function of the electric field, the form of which depends on the type of magnetic trap. The main physical mechanism determining the anomaly of the resistance is the current instabilities and, above all, the ion sound instability. For large electric fields the measured electric conductivity of a plasma is proportional to $\sqrt{n}$ and does not depend on the strength of the electric field and the temperature of the plasma. The dynamics of current instabilities in a discharge are investigated, and their importance in the process of the development of a gaseous discharge is explained. The experimental values of the electrical conductivity of a plasma are found to be in good quantitative agreement with theory. (auth)

21987 PHOTODECAY OF A NEGATIVE NITROGEN ION IN A PLASMA. Kobzev, G. A. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 1, 18-21(Jul 1971).

Translated from Opt. Spektrosk.; 31: No. 1, 37-42(Jul 1971).

Experimental data on the continuous emission of nitrogen and air plasma in the temperature range of 10,000 to 17,000 K at pressures of 1 to 100 atm are considered. The magnitude and nature of the excess radiation recorded in experiments under atmospheric pressure are studied. An analysis is made of the sensitivity of the previously calculated value of the photodecay cross section of the negative nitrogen ion N^- to variations in the wave functions. The effect of the interaction between the charged particles on the weakly bound N^- ion in the ^3P state was examined. On the basis of the mass of experimental and theoretical data, it is concluded that the excess radiation in the nitrogen and air plasmas, with the parameters investigated, is explained by photorecombination with the formation of N^- in the ^3P state. The photodecay cross section of the latter ion is (3 to 5) $\times 10^{-17}$ cm^2. The smallness of the excess radiation experimentally observed at pressures of 10 to 150 atm is explained by the effective destruction of the weakly bound N^- (^3P) ions in the plasma microfields. A method for calculating the excess continuum at various pressures is discussed, as are the prospects for further research. (auth)

21988 LASER ACTION IN Na–H_2 AND K–H_2 MIXTURES WITH PULSED INJECTION OF METAL VAPOR INTO A GAS-DISCHARGE PLASMA. Mishakov, V. G.; Tibilov, A. S.; Shukhtin, A. M. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 2, 176-7(Aug 1971).

Translated from Opt. Spektrosk.; 31: No. 2, 324-5(Aug 1971).

Laser action in Na–H_2 and K–H_2 mixtures produced by current-pulse heating of a metal layer on the wall of a discharge tube and by a second current pulse was previously produced (Opt. Spectrosc. (USSR) (Engl. Transl.), 21: 69(1966) and 25: 301(1968)). If the duration of first pulse is increased, laser action in all four transitions took place in the trailing edge of the first pulse. This effect occurs only when there is a metal layer of Na or K on the tube surface and for current densities of ~10 A/cm^2. Preliminary heating of the wall also increases this laser action. The plasma layers near the wall begin to lose first, followed by the central regions of the discharge tube. (D.L.C.)

21989 MOTION OF PLASMOIDS INJECTED INTO A CUSP FIELD. Ozaki, Atsuhiko; Ishimura, Tsutomu (Osaka Univ., Suita, Japan). J. Phys. Soc. Jap.; 32: No. 3, 824-30(Mar 1972).

Motion of a dense ($10^{15} \sim 10^{16}$ particles/cm^3) hydrogen plasma injected with a linear-pinch gun into a biconical cusp field was observed with magnetic probes, a streak camera, and a Kerr-cell camera. An axial reciprocating motion of the blob is observed and it is explained as a motion of a filament current ring with finite electrical conductivity. This reciprocating motion disappears in a few cycles and the plasma simultaneously interdiffuses with the magnetic field. Finite electrical conductivity of the plasma gives some contribution to the dissipation of the directional energy of the injected plasma. (auth)

21990 ELECTRON CYCLOTRON EMISSION FROM A REFLEX DISCHARGE PLASMA. Hanisch, J. L.; Stetson, R. F. (Florida Atlantic Univ., Boca Raton). Plasma Phys.; 13: No. 11, 1059-65(Nov 1971).

A low-temperature reflex discharge was employed to study cyclotron harmonic generation in a helium plasma. Changing the discharge parameters caused the onset of harmonics. The plasma characteristics were studied for conditions when the harmonics were present and compared to conditions when the harmonics were not present. Contrary to previous experimental results, the plasma frequency and the upper hybrid frequency were well below the observed harmonic frequency. Electron densities were measured using a microwave interferometer, reflection of microwaves at the upper hybrid frequency, and Langmuir probes and were ~10^{11} cm^{-3}. (auth)

21991 FLOW VELOCITY MEASUREMENTS IN A T TUBE. Strachan, J. D.; Ahlborn, B.; Huni, J. P. (Univ. of British Columbia, Vancouver). Phys. Fluids; 15: No. 4, 603-9(Apr 1972).

The flow velocity of a T-tube plasma was measured by recording the attenuation of a known shock wave propagating through the T-tube flow. This technique yields results with typical accuracies of 0.1 km/sec which is about 10% of the velocity of the probing shock. The interpretation of the results invites a comparison of the T-tube flow field with an overexpanded detonation or breakdown wave in the high-velocity regime and with a radiation driven shock front in the low-velocity regime. (auth)

21992 MEASUREMENT OF THE ELECTRIC CONDUCTIVITY OF A DENSE HIGHLY NONIDEAL CESIUM PLASMA. Barol'skii, S. G.; Ermokhin, N. V.; Kulik, P. P.; Mel'nikov, V. M. (Moscow Aviation Inst.). Zh. Eksp. Teor. Fiz.; 62: No. 1, 176-82(Jan 1972). (In Russian).

Results of measurement of the electric conductivity of a dense highly nonideal ($\gamma = e^2n_e^{1/3}/kT \gg 1$) cesium plasma carried out on two types of experimental arrangments are presented. One assembly is of the "Ohm furnace" type and the other is a pulsed type of assembly. The experiments are performed at temperatures between 1000 and 10,000°K and pressures between 130 and 350 atm. The results of the experiments show that heating of a dense plasma results in a sharp drop of the electric conductivity in the vicinity of the low temperature $T \approx 2000°$; at higher temperatures $5000 \leq T \leq 10{,}000°$K, the electric conductivity becomes anomalously high, close to values of the metal. There are indications that with increase of pressure, the electric conductivity drop decreases. A short analysis of physical effects which may occur in the plasma under the conditions of the experiments is presented. (auth)

Kinetics (Theoretical)

Refer also to abstracts 21331 and 22175.

21993 (AD-731767) ONE-ELECTRON ATOM IMMERSED IN A PLASMA. Ross, R. L. (Army Electronics Command, Fort Monmouth, N. J.). Jun 1971. 45p. (ECOM-3434). NTIS.

The problem of an electron which is both bound in an attractive screened Coulomb potential and under the simultaneous influence of an external electric field is considered. The total energy Hamiltonian is derived for the case of a one-electron atom immersed in a plasma. A suitable ground-state trial wave function incorporates the appropriate induced dipole character of the charge configuration when subjected to the plasma's free-particle uniform electric field. A variational-principle calculation of the ground-state energy is performed and compared with second-order perturbation theory. The ionization field for the hydrogen 1s state is determined and found to give a new upper bound. The effect of screening and electric field on other observables is likewise calculated. The disappearance of spectral lines originating from high energy levels, which has been shown to occur in both solar and laboratory hydrogen plasmas, is discussed. The value of inverse Debye length resulting in the true experimental value of the ionization field for the hydrogen 1s-state is determined. Conclusions are drawn, and recommendations given for future areas of investigation. (auth) (USGRDR)

21994 (TID-25912) COMMENTS ON PARTICLE SIMULATION OF PLASMAS. Dawson, John M. (Princeton Univ., N. J. Plasma Physics Lab.). [1971]. Contract AT(30-1)-1238. 10p. Dep. NTIS.

Computer simulation of plasmas using particle models is reviewed. The different techniques combined with present computers are discussed in particular. (M.O.W.)

21995 NUMERICAL SIMULATION OF PLASMAS WITH PERIODIC SMOOTHING IN PHASE SPACE. Denavit, J. (Naval Research Lab., Washington, D. C.). J. Comput. Phys.; 9: No. 1, 75-98(Feb 1972).

A "hybrid" method is presented for numerical simulation of collisionless plasmas in which weighted particles are advanced as in particle simulations, but in which the distribution function is reconstructed periodically by a local averaging operation as in numerical solutions of the Vlasov equation. The rates of diffusion resulting from repeated averaging of the distribution function are estimated. These rates indicate that it is possible to minimize the effects of both beaming instabilities and diffusion

by properly choosing the frequency of reconstruction of the distribution function. A computer code was written to implement this method and numerical solutions of two-stream instability problems are presented. (auth)

21996 SPECTRAL LINE BROADENING BY ELECTRONS IN NONEQUILIBRIUM PARTLY IONIZED PLASMA. Asmaryan, E. A.; Klimontovich, Yu. L. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 1, 14-17(Jul 1971).

Translated from Opt. Spektrosk.; 31: No. 1, 30-6(Jul 1971).

The resonant line width due to longitudinal Coulomb interactions of the emitting atoms with electrons in a nonequilibrium velocity distribution is calculated. (auth)

21997 METHODS IN NONLINEAR PLASMA THEORY. Davidson, Ronald C. Pure and Applied Physics, Volume 37. A Series of Monographs and Textbooks. New York; Academic Press Inc. (1972). 371p. $18.50.

Various mathematical methods useful in nonlinear plasma theory are discussed, including the method of characteristics, the transformation of nonlinear equations to equivalent linear equations, and the multiple-time-scale perturbation formalism. Each topic and method is presented in a thorough and self-contained manner. Part I deals with coherent nonlinear phenomena, where no assumption is made regarding the randomness of wave phases. Part II deals with turbulent nonlinear phenomena in a homogeneous plasma. (M.O.W.)

21998 ELECTROSTATIC FIELDS AND ION SEPARATION IN EXPANDING LASER PRODUCED PLASMAS. Mulser, P. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Plasma Phys.; 13: No. 11, 1007-12(Nov 1971).

The separation of ions of different charges in a plasma produced by laser irradiation of a solid target is investigated theoretically. For this purpose the equations of motion are solved numerically for plane and spherical geometry, including the influence of the electrostatic field in the plasma. It is shown that the expansion velocities of ions of different charges are equal as soon as the friction between the species is included. Thus, contrary to the suggestions of several authors, the experimentally observed separation of ions cannot be explained by the different forces acting upon them in the electric field, but must be due to other effects, e.g., to inhomogeneities of the power density in the laser spot. (auth)

21999 NONEQUILIBRIUM VISCOUS SHOCK LAYER IN A PARTIALLY IONIZED GAS. Nishida, M. (Kyoto Univ.). Phys. Fluids; 15: No. 4, 596-602(Apr 1972).

The structure of a nonequilibrium, partially ionized viscous shock layer of a blunt body which is at floating potential is described. Electron temperature and electron–ion density profiles across the shock layer are theoretically investigated for the case where electrons are in thermal nonequilibrium with heavy particles in a free stream. Immediately behind the shock, the electron temperature profile across the shock layer is matched with that in a free stream, using the relation for the jump of the electron temperature gradient across the shock. The method of matching is described. Dependence of the electron temperature profile across the shock layer upon the degree of thermal nonequilibrium in the free stream is investigated. (auth)

22000 REVISION AND TEST OF THE QUASI-LINEAR THEORY. Burns, Thomas; Knorr, Georg (Univ. of Iowa, Iowa City). Phys. Fluids; 15: No. 4, 610-19(Apr 1972).

The quasi-linear theory is revised analytically and its consequences are tested by a numerical simulation for a one-dimensional periodic electron plasma with discrete electrostatic modes. The theory is formulated for unstable and damped modes, and a series of constants of motion derived. The numerical model is a Vlasov–Poisson system where the mode–mode coupling terms were omitted. The result is that the predictions of the analytical theory are confirmed by simulation. For all cases considered there are always several modes that are initially unstable, but become damped at a later time so that an inclusion of damped modes in the theory is absolutely necessary. (auth)

22001 CONDUCTIVITY OF A TWO-DIMENSIONAL GUIDING-CENTER PLASMA. Montgomery, David (Bell Telephone Labs., Whippany, N. J. Univ. of Iowa, Iowa City); Tappert, Frederick. Phys. Fluids; 15: No. 4, 683-7(Apr 1972).

The Kubo method is used to calculate the electrical conductivity of a two-dimensional, strongly magnetized plasma. The particles interact through (logarithmic) electrostatic potentials and move with their guiding center drift velocities (Taylor–McNamara model). The thermal equilibrium dc conductivity can be evaluated analytically, but the ac conductivity involves numerical solution of a differential equation. Both conductivities fall off as the inverse first power of the magnetic field strength. (auth)

22002 PLASMA MAGNETIZATION AND THE DETERMINATION OF HYDROMAGNETIC EQUILIBRIUM. Hall, Laurence S. (Univ. of California, Livermore. Univ. of California, Davis). Phys. Fluids; 15: No. 4, 710-12(Apr 1972).

Equilibrium of a plasma and a magnetic field is determined through a plasma magnetization M with both local and nonlocal contributions. The equations of equilibrium are thus posed in soluble form, $\nabla \times H = 0$ and $\nabla \cdot B = 0$ with $B = H + 4\pi M$, possible previously only when pressures depended on $|B|$ alone. (auth)

22003 LOW-CURRENT RELATIVISTIC BEAM EQUILIBRIA. Leary, James M.; Lee, Edward P. (Univ. of California, Livermore). Phys. Fluids; 15: No. 4, 716-18(Apr 1972).

A simple procedure yields isotropic beam equilibria with given current profile and energy distribution in the limiting case of the beam current small compared with the Alfvén current. (auth)

22004 TURBULENT DIFFUSION IN PHASE SPACE. Thomson, J. J.; Benford, Gregory (Univ. of California, Irvine). Phys. Rev. Lett.; 28: No. 10, 590-3(6 Mar 1972).

A new theory of plasma turbulence is formulated that begins by viewing particle diffusion in phase space as a Weiner process. The turbulent particle propagator is constructed from physical arguments and a general expression is found for the turbulent diffusion coefficient and dielectric function. Earlier results of Dupree and others are extended and clarified. The method readily applies to turbulent problems with boundary conditions on the particle distribution. (auth)

Production

22005 (EUR-CEA-FC-624) PROCESSES INVOLVED IN IMPURITY IONIZATION IN HOT PLASMAS. Bliman, S. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov 1971. 16p. (In French). Dep. NTIS (U. S. Sales Only).

Collisions producing multiply charged heavy ions are examined, specifically, successive and shake-off ionization for impurities in hot plasmas. (France)

22006 INTERACTION OF A LASER BEAM WITH A TARGET. Bobin, J. L.; Tonon, G. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Bull. Inform. Sci. Tech. (Paris); No. 160, 23-38(Jun 1971). (In French).

The mechanisms involved in the interaction of a laser beam with a solid target are reviewed. Fluxes less than 10^{13} W/cm^2 are considered. It is shown that multiply charged heavy ions are generated by the strong heating of the plasma ejected from the target. Subsequent expansion prevents the ions from slowing down and recombining with background electrons. They can thus be detected far from the target using mass spectrometry. (France)

22007 ANGULAR DISTRIBUTION OF THE IONS OF A LASER PLASMA. Bykovskii, Yu. A.; Gryukhanov, M. F.; Degtyarev, V. G.; (and others) (Inst. of Engineering Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 4, 157-9(20 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 4, 238-42(20 Aug 1971).

To obtain the angular distribution, a special ion-source chamber was used in which the angle between the plane of the target and the laser radiation direction remain unchanged with changing angle between the target plane and the ion-optical axis of the instrument. Diagrams of energy and angular distributions are given. (M.O.W.)

22008 PLASMA ACCUMULATION BY IONIZATION OF RESIDUAL GAS IN AN ELECTROMAGNETIC TRAP. Pankrat'ev, Yu. I.; Nozrachev, M. G.; Lavrent'ev, O. A.; (and others). At. Energ. (USSR); 32: No. 2, 131-6(Feb 1972). (In Russian).

The ions produced in the process of ionization accumulated at the bottom of the potential well. The accumulation proceeded until the density reached a critical value determined by the value of the magnetic field, magnetic cusp thickness, and electrostatic potentials in the cusps. For magnetic fields of 5500 gauss, the density of the plasma accumulated in the trap was about 10^{12} cm^{-3}, and the mean particle lifetime was 5 to 10 msec. The mean electron energy was 1 keV. (auth)

22009 APPARATUS FOR THE PRODUCTION OF HIGHLY STRIPPED IONS. Stix, Thomas H. (to United States Atomic

Energy Commission). U. S. Patent 3,634,704. 11 Jan 1972. Filed 2 Sep 1970.

Apparatus is described for producing highly stripped ions having a negatively biased plasma with energetic magnetic-mirror confined electrons that provides a suitable environment for long-term ion confinement and for intense multiple ionization of heavy ions. Classical rates for ion loss from a negative potential well are low compared to the comparable ion mirror loss rates. The plasma is maintained by steady electron injection, together with cyclotron acceleration for electron trapping and heating. (auth)

22010 PRODUCTION OF A HIGH TEMPERATURE DEUTERIUM PLASMA BY LASER IRRADIATION OF A SPECIAL GAS TARGET. Pashinin, P. P.; Prokhorov, A. M. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 189-94(Jan 1972). (In Russian).

An estimate is made of the electron temperature during laser heating of a deuterium plasma; a special gas target is used which is a cylindrical tube closed at the ends by a thin film and filled with gaseous deuterium. Optimization of the experimental parameters such as pulse duration and tube diameter (focussing sharpness) is carried out for various initial gas pressures and a given energy and for various values of the longitudinal external magnetic field strength. The dependence of the plasma temperature and neutron yield on laser pulse energy are calculated for an optimal configuration. (auth)

22011 ENERGY SPECTRUM OF MULTICHARGED IONS IN A LASER PLASMA. Afanas'ev, Yu. V.; Rozanov, V. B. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 247-52(Jan 1972). (In Russian).

The energy spectrum of ions of various multiplicity in a plasma produced by laser irradiation is investigated theoretically. Analytic expressions for the ion energy distribution functions are derived under some assumptions regarding the nature of hydrodynamic dispersal of the plasma. It is shown that recombination processes strongly affect the spectra. (auth)

22012 POWERFUL LASER ARRANGEMENT AND INVESTIGATION OF THE EFFICIENCY OF HIGH TEMPERATURE HEATING OF A PLASMA. Basov, N. G.; Krokhin, O. N.; Sklizkov, G. V.; Fedotov, S. I.; Shikanov, A. S. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 203-12(Jan 1972). (In Russian).

An experimental laser arrangement for high-temperature heating of a solid target is described. A powerful neodymium glass laser is set up that produces controllable pulses with durations between 2 and 16 nsec and a radiation energy of 600 to 1300 J. An electro-optical shutter controlled by a discharger with laser ignition is employed for formation of the light pulse. The contrast of the output radiation is $\sim 10^{-7}$. The radiance is 3×10^{16} W/cm^2 · sterad. The mean irradiance at the target surface reaches 10^{16} W/cm^2. The maximum output energy of the laser is found to decrease with reduction of pulse duration. Preliminary experiments are carried out on heating of a spherical polyethylene target. Ultrarapid photography with a ruby laser ray is used for diagnostics of the heated plasma. The energy absorbed by the plasma is determined on the basis of the velocity of the spherical shock wave produced as a result of expansion of the target in the gas. In the experiments, this energy for a pulse duration of 2 nsec is ~300 J. The results and promising lines of investigation are discussed. (auth)

Stability

22013 NONLINEAR SATURATION OF PARAMETRIC INSTABILITIES. Bezzerides, Bandel; Weinstock, Jerome (National Oceanic and Atmospheric Administration, Boulder, Colo.). Phys. Rev. Lett.; 28: No. 8, 481-4(21 Feb 1972).

A theory is presented for the nonlinearly saturated levels of Langmuir and acoustic waves produced by parametric instabilities. The theory accounts for the perturbations of particle orbits by waves. The results are quantitatively compared with recent simulations by Kruer and Dawson. (auth)

22014 RADIAL DEPENDENCE OF THE COLLISIONAL TRAPPED-PARTICLE INSTABILITY. Ross, David W.; Horton, C. W. Jr. (Univ. of Texas, Austin). Contracts AT(40-1)-3458; AT(30-1)-3927. Phys. Rev. Lett.; 28: No. 8, 484-8(21 Feb 1972).

The effects of temperature gradient and magnetic shear on the radial dependence of the collisional trapped-particle mode are studied. The former produces a reflecting layer at the edge of the plasma, while the latter introduces fine structure in the untrapped-particle terms. It is concluded, contrary to a published result, that unstable eigenmodes are likely to occur in large tokamaks. Untrapped-ion resonances near the rational flux surfaces provided a stabilizing effect, however. (auth)

22015 ION-ACOUSTIC INSTABILITY IN A TWO-TEMPERATURE COLLISIONAL PLASMA. Kaw, P. K.; Sundaram, A. K. (Physical Research Lab., Ahmedabad, India). Phys. Lett.; 38A: No. 5, 355-6(28 Feb 1972).

It is shown that, if one takes into account the nonstationary nature of the background equilibrium, ion acoustic waves in a two-temperature, collisional, fully ionized plasma are stable. (auth)

22016 STABILIZATION OF UNSTABLE PLASMA OSCILLATIONS BY DISTRIBUTED CONTROL. Ladikov-Roev, Yu. P. Kibern. Vychisl. Tekh.; No. 1, 54-62(1969). (In Russian).

If a plasma and the surrounding magnetic field are considered to be a single system, the problem of stabilizing the plasma is, in reality, a search for the configuration that provides self-compensation. The operator for the regulating component is assumed to be known, and the stability of a closed plasma system (a regulating medium in the simplest cases) is investigated. A set of dispersion equations (from Vlasov) representing plasma oscillations in the presence of a regulating medium is developed. In a second analysis, the stabilization of some unstable longitudinal plasma oscillations is investigated with the aid of regulating shells. (K.S.W.)

22017 MICROINSTABILITY OF MIRROR-CONFINED ENERGETIC PLASMA IN AN RF ELECTRIC FIELD. Kishimoto, Shun-ichi; Akimune, Hideo; Suita, Tokuo (Osaka Univ.). J. Phys. Soc. Jap.; 32: No. 3, 796-807(Mar 1972).

Microinstability of the mirror-confined plasma (mean ion energy is 5 ~ 10 keV and maximum density is 7×10^7 cm^{-3}) under an rf electric field, $\omega_0 = 2.5\omega_{ci}$ was investigated experimentally and theoretically, where ω_0 is the frequency of the rf field and ω_{ci} is the ion cyclotron frequency. The frequency of the observed oscillation, which is satisfactorily explained as a temporal growing loss-cone instability, is above or nearly equal to $4\omega_{ci}$. It seems, as predicted by the calculation, to shift slightly from $4\omega_{ci}$ by the effect of the rf field. This instability oscillation is damped with the rf field. The stabilization is owing to the energy spreading of ions and owing to the electron drifts induced by the rf field whose frequency is off-resonant from the ion cyclotron frequency and its harmonics. (auth)

22018 EXCITATION AND STABILIZATION OF MICROINSTABILITIES BY RF ELECTRIC FIELD. Kishimoto, Shun-ichi; Akimune, Hideo; Suita, Tokuo (Osaka Univ.). J. Phys. Soc. Jap.; 32: No. 3, 808-23(Mar 1972).

Effects of a weak rf electric field, parallel to the magnetic field, on microinstabilities driven by a nonMaxwellian distribution are investigated theoretically and experimentally. Concerning nonMaxwellian instability, excitation and stabilization of the instability are observed in a certain frequency region of the rf field: $\omega_{ci} \lesssim \omega_0 \lesssim 2\omega_{ci}$, where ω_0 and ω_{ci} are the frequency of the rf field and the ion cyclotron frequency, respectively. The calculation indicates that the stabilization is due to the induced electron drifts and that the excitation is caused by the mode–mode couplings. Anisotropic instability is studied only theoretically under the rf field: $\omega_0 \approx \omega_{ci}$. This instability can be smoothly stabilized through Landau damping due to the electrons heated along the magnetic field by the rf field. (auth)

22019 INSTABILITY OF TWO-DIMENSIONAL COLLISIONLESS PLASMAS WITH NEUTRAL POINTS. Biskamp, D. (Institut fuer Plasmaphysik, Garching, Ger.); Schindler, K. Plasma Phys.; 13: No. 11, 1013-26(Nov 1971).

In the framework of Vlasov theory, the stability of two-dimensional plasmas with neutral points is discussed. Some general stability criteria are derived for situations where a typical electron Larmor radius (away from the neutral points) is much smaller than the characteristic length of the magnetic field. As an example a sheet pinch with a periodic structure is discussed. It is found that the mode corresponding to coalescence of two neighbouring pinches is unstable, and the growth rate γ is estimated, γ turns out to be larger than the growth rate for the tearing mode of a plane sheet. Some remarks concerning single-particle acceleration are added. (auth)

22020 NON-LINEAR STAGE OF PLASMA HYDRODYNAMIC CURRENT INSTABILITY IN A STRONG ELECTRIC FIELD. Sizonenko, V. L.; Stepanov, K. N. (Physical-Technical Inst., Kharkov). Plasma Phys.; 13: No. 11, 1033-50(Nov 1971).

The development of a hydrodynamic "Buneman" current instability of plasma in a strong electric field E is investigated.

The velocity of the electrons relative to the ions is assumed to be greater than the electron thermal velocity. The nonlinear stage of current instability is examined for the one-dimensional case in which electrons move only along an external magnetic field H_0 which is parallel to E. It is shown that in this case the growth of the oscillations and drift velocity are not stabilized even in the strong nonlinear regime when the fluctuation amplitudes both of electron and ion density and of the electron velocity become of the same order as their equilibrium values. (UK)

22021 ELECTROSTATIC STABILITY THEORY OF TOKAMAKS FROM TWO-COMPONENT FLUID EQUATIONS. Horton, C. W. Jr.; Varma, R. K. (Univ. of Texas, Austin). Phys. Fluids; 15: No. 4, 620-31(Apr 1972).

The electrostatic stability theory of tokamak plasmas is developed from the two-component fluid equations. The consistent treatment of the collisional equations with the transport processes from Coulomb scattering shows the relative importance of the transport processes of resistivity, viscosity, the thermoelectric effect, and thermal conduction in the several plasma modes. The plasma modes derived from the electrostatic equations are the sound waves, the drift wave, and thermal modes. The growth rates are given as functions of the driving forces of the tokamak current, the density gradient, and the temperature gradients. At finite aspect ratio, the equations describing the current driven drift-sound waves are solved for the toroidal shift in the growth rate. In addition to the gradient-B drifts previously modeled by a periodic gravity, it is shown that consistency requires inclusion of the plasma compression due to the modulation of the parallel and perpendicular fluxes in the nonuniform magnetic field. (auth)

22022 EFFECT OF FINITE β ON THE DRIFT CYCLOTRON INSTABILITY. Bajaj, N. K.; Krall, N. A. (Univ. of Maryland, College Park). Phys. Fluids; 15: No. 4, 657-61(Apr 1972).

The effect of finite β (particle pressure/magnetic pressure) on the drift-cyclotron instability is investigated. It is shown that for $\beta < [(B^2/4\pi mMc^2) + (m/M)]^{\frac{1}{2}}$ the instability range is shifted but not reduced, whereas, for $\beta > [(B^2/4\pi mMc^2) + (m/M)]^{\frac{1}{2}}$ the growth of the drift-cyclotron mode is much reduced. (auth)

22023 THEORY AND SIMULATION OF THE BEAM CYCLOTRON INSTABILITY. Lampe, M.; Manheimer, W. M.; McBride, J. B.; (and others) (Naval Research Lab., Washington, D. C.). Phys. Fluids; 15: No. 4, 662-75(Apr 1972).

A detailed theory in conjunction with the results of computer simulation experiments is presented for the beam cyclotron instability. The main results are (1) After a period of exponential quasi-linear development, turbulent wave-particle interactions cause cross-field diffusion of the electrons which smears out the electron gyroresonances. This occurs at a level of turbulence which scales as $\Sigma_k(|E_k|^2/4\pi N_0 T_e) \sim (\Omega_e/\omega_e)^2(\Omega_e/kv_e)$, where Ω_e and ω_e are the electron cyclotron and plasma frequencies, and results in a transition to ordinary ion sound modes that would occur in an unmagnetized plasma. The magnetic field serves to reduce the effects of electron trapping. (2) This level of turbulence appears to have virtually no effect on long wavelength fluid modes. (3) At this level the instability stabilizes if ordinary ion sound is stable due to ion Landau damping. For cold ions it continues to develop at the slower ion acoustic growth rate until the fields become strong enough to trap the ions. After the fields saturate, further plasma heating is much slower than exponential. (auth)

22024 INVESTIGATION OF DRIFT BEAM INSTABILITY OF A PLASMA–ION BEAM SYSTEM IN A LONGITUDINAL MAGNETIC FIELD. Gabovich, M. D.; Pashitskii, E. A.; Protsenko, I. M.; Poritskii, V. Ya.; Simonenko, L. S. (Inst. of Physics, Kiev). Zh. Eksp. Teor. Fiz.; 62: No. 1, 195-202(Jan 1972). (In Russian).

Drift-beam instability in a plasma-ion beam system located in a longitudinal magnetic field is studied theoretically and experimentally. It is found that, in a system consisting of two opposite argon or helium beams with equal current strengths and energies and moving through their own gas at a pressure of 2×10^{-5} to 7×10^{-4} mm Hg along a magnetic field of 2 to 10 kOe, oscillations are excited with frequencies that are several times greater than the respective ion-cyclotron frequencies. The experimental data are in satisfactory agreement with the theoretical analysis. (auth)

Thermonuclear Processes

Refer also to abstract 21963.

22025 (IPP–4/91) APPLICATION OF SUPERCONDUCTIVITY IN THERMONUCLEAR FUSION RESEARCH. Martinelli, A. P. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct 1971. 23p. Dep. NTIS (U. S. Sales Only).

Recent technological developments of high-field superconducting materials and cryogenic, adiabatic, and dynamic stabilization methods are briefly examined. The high-current densities attainable in superconducting magnets, the design and operation reliability, and the economy in comparison with traditional magnets make superconducting magnets attractive for plasma physics experiments. Furthermore, the absence of ohmic resistance in superconductors makes experimental configurations feasible that could not be built otherwise. Two experiments are described, the WENDELSTEIN 6 quadrupole and the WENDELSTEIN 7 stellarator, which are being constructed and planned, respectively, at Garching. The geometric dimensions and the high magnetic field values required for possible future thermonuclear reactors can only be achieved by using superconducting magnets. Since they represent the major expenditure for a reactor, the total cost will depend on the production and economic use of high- and very-high-field materials. (auth)

22026 MOTION OF CHARGED PARTICLES IN A MULTIPLE-LENS ACCELERATOR. Volkov, T. F. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 988-94(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1257-66(Jun 1971).

The motion of charged particles in the spatially periodic magnetic field of a multiple-lens accelerator is treated. General equations suitable for determining the motion and trajectory of a particle are obtained for arbitrary initial positions and momenta. The motion of particles trapped within a single section, near a zero field line, is also studied. The effect of the cylindrical symmetry of the system is evaluated. It is assumed that the acceleration in the last edge sections can be neglected. (auth)

22027 MAGNETIC SYSTEM OF A MULTIPLE-LENS ACCELERATOR. Volkov, T. F.; Morozov, A. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 6, 981-7(Dec 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 6, 1247-56(Jun 1971).

The magnetic field in a multiple-lens accelerator is calculated. The field in an infinite accelerator is determined first; corrections are then introduced to describe the field in a finite system. The results are in agreement with experimental observations. (auth)

22028 NEUTRON ENERGY AND FLUX DISTRIBUTIONS FROM A CROSSED-FIELD ACCELERATION MODEL OF PLASMA FOCUS AND Z-PINCH DISCHARGES. Bernstein, M. J.; Comisar, G. G. (Aerospace Corp., El Segundo, Calif.). Phys. Fluids; 15: No. 4, 700-6(Apr 1972).

Anisotropic distributions of neutron fluxes and neutron energy spectra are calculated for D–D reactions in self-pinching discharges, particularly for a plasma focus. A generalized beam–target model is assumed where (1) high-energy deuterons have angular distributions consistent with a crossed-field acceleration mechanism, and (2) these energetic deuterons undergo fusion collisions primarily with stationary target ions. Energy distributions of ions proportional to E_d^{-3} in the range from 50 to as high as 600 keV give computed results agreeing with many experimental observations at laboratory angles of 0, 90, and 180°. These ion-energy distributions can account for a 50- to 100-fold increase in neutron yield when a deuterium–tritium gas mixture is used. (auth)

Wave Phenomena

22029 (AD–487538) OBSERVATION OF CYCLOTRON ECHOES FROM A HIGHLY IONIZED PLASMA. Kaplan, Daniel E.; Hill, Robert M.; Wong, Alfred Y. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). 1 Aug 1966. Contract Nonr-2541(00). 10p. NTIS.

The observation of cyclotron echo phenomena from an almost fully ionized cesium plasma in the UCLA Q device is reported. Characteristics of two- and three-pulse cyclotron echoes in this plasma media and the implication of these measurements for a velocity-dependent collision frequency mechanism of cyclotron echo formation are discussed. (auth) (USGRDR)

22030 (AD–732045) ASYMPTOTIC THEORY OF NONLINEAR WAVE MOTIONS IN MAGNETOHYDRODYNAMICS. III. AXISYMMETRIC WAVES. Shen, M. C. (Wisconsin Univ., Madison. Mathematics Research Center). Jul 1971. Contract DA-31-124-ARO(D)-462. 27p. (MRC-TSR-1131). NTIS.

An asymptotic approach based upon Lundquist equations is developed for the study of nonlinear wave propagation on a pinch cylindrical plasma. Wave speed and asymptotic evolution equa-

tions are derived. A comparison between linear stability criteria and results of the nonlinear theory is made and a set of refined stability criteria is obtained. (auth) (USGRDR)

22031 (SC-T-722463) EXCITATION OF LONGITUDINAL ELECTROMAGNETIC WAVES IN A FINITE PLASMA ON INJECTION OF RELATIVISTIC ELECTRON BEAMS. Bogdankevich, L. S.; Rukhadze, A. A. Translated by Patricia Newman (Sandia Labs., Albuquerque, N. Mex.), from Conference on Plasma Theory, Kiev, USSR, October 19–23, 1971. 29p. (CONF-711016–8). Dep. NTIS.

A detailed analysis is given of the nature and conditions of excitation of longitudinal electromagnetic waves in a spatially limited magnetoactive plasma by a low-density relativistic electron beam. The growth rates, frequency spectra, and spectral widths of the plasma waves generated by the beam are determined. Linear evaluations are given of the maximum amplitude of the established oscillations. The results are discussed: (a) from the point of view of using powerful relativistic electron beams for generating plasma waves of high amplitude, and (b) in an example of probing the earth's ionosphere with a low-power relativistic beam. (auth)

22032 OBSERVATION OF STABLE, HIGH-MACH-NUMBER ELECTROSTATIC SHOCKS IN A COLLISIONLESS PLASMA. Honzawa, T. (Nagoya Univ., Japan). Phys. Lett.; 38A: No. 5, 318-20(28 Feb 1972).

Observation of stable, large-amplitude ion-acoustic shocks with a high Mach number M > 1.6 in a collisionless plasma is described. Discussions about the nature and behavior of the waves are also given. (auth)

22033 EXCITATION OF MAGNETOSONIC RESONANCE IN THE TOKAMAK PLASMA. Vdovin, V. L.; Zinov'ev, O. A.; Ivanov, A. A.; (and others). JETP Lett. (USSR) (Engl. Transl.); 14: No. 4, 149-52(20 Aug 1971).

[28]Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 4, 228-31(20 Aug 1971).

The excitation of magnetosonic resonance was investigated in a torus with major radius 40 cm, diaphragm radius 8 cm, stabilizing field 20 kOe, and discharge current 10 kA. The magnetosonic oscillations at 21 MHz were excited with a narrow coupling loop surrounding the plasma column. A diagram shows the following: an oscillogram of the emf from the magnetic field, showing the time behavior of the H_z component of the hf magnetic field, and the current in the plasma. (M.O.W.)

22034 GENERATION OF MAGNETOSONIC OSCILLATIONS IN THE TOKAMAK TO-1. Ivanov, N. V.; Kovan, I. A.; Los, E. V. JETP Lett. (USSR) (Engl. Transl.); 14: No. 4, 138-40(20 Aug 1971).

[28]Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 4, 212-14(20 Aug 1971).

In connection with the prospects of using magnetosonic resonance for additional heating of the plasma in the tokamak, a study was made of the possibility of exciting natural oscillations of the plasma column using an hf amplifier in a feedback loop via the plasma. The spectra of the natural oscillations were first studied. Self-excitation of the oscillations was described. (M.O.W.)

22035 KOLEBANIYA I VOLNY V PLAZME. (Oscillations and Waves in a Plasma). El'yashevich, M. A. (ed.). Minsk; Izdatel'stvo Nauka i Tekhnika (1971). 152p.

This volume contains 45 papers taken from the larger number which were presented at the 2nd All-Union Conference of the Physics of A Low Temperature Plasma. Problems arising from low- and high-frequency oscillations in a plasma and the effect of various experimental conditions on the character of such oscillations are discussed. Both theoretical and experimental studies on plasma parameters in connection with oscillations are reported. Certain papers describe the processes of interaction between electromagnetic fields and a plasma. Nonlinear effects on plasma characteristics and plasma instabilities are considered. Additional papers from this conference appeared in the volume "Problems of The Physics of A Low Temperature Plasma" (1970, 677 pages), for which a separate abstract is included. (K.S.W.)

22036 EFFECT OF LOW-FREQUENCY OSCILLATIONS ON MICROWAVE SIGNAL ATTENUATION IN A PLASMA–BEAM DISCHARGE. Kirdyashev, K. P.; Zaikina, A. N. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 3, 484-90(Mar 1971).

Translated from Radiotekh. Elektron.; 16: No. 3, 358-65(Mar 1971).

Measurements of microwave signal attenuation in a plasma–beam discharge are presented. The conditions of anomalous attenuation are explained and the relationship of the attenuation characteristics and amplitude fluctuations with the low-frequency oscillation intensity and spectrum is established. The mechanism for the scattering of the probe signal by plasma oscillations, arising because of beam-drift instability and resulting in anomalous attenuation, is discussed. Numerical calculations and a qualitative discussion of the effect of low-frequency oscillations allow conclusions to be drawn concerning the predominant contribution of this effect, compared with the mechanism of deceleration cyclotron absorption. (auth)

22037 POSSIBILITY OF FREQUENCY CONVERSION IN A MAGNETOACTIVE PLASMA IN THE TRAVELING-WAVE MODE OF OPERATION. Shtykov, V. V.; Kovalenko, Yu. F. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 3, 556-8 (Mar 1971).

Translated from Radiotekh. Elektron.; 16: No. 3, 443-5(Mar 1971).

A signal buildup effect at the difference frequency is possible for microwave oscillations in magnetoactive plasma in the traveling wave mode. To clarify the possibility of frequency conversion and to evaluate its parameters, an idealized problem is considered, assuming that the heterodyne and signal waves are the H_{10}-type waves of a rectangular waveguide. Magnetization calculations are also made. (M.O.W.)

22038 INFLUENCE OF OSCILLATIONS IN A PLASMA ON POPULATION OF EXCITED STATES. Kogan, E. Ya.; Fisun, O. I. (Inst. of Semiconductors, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 8, 1374-7(Aug 1971). (In Russian).

For localizing functions of the distribution of atoms throughout their excited states, the probability of all elementary processes that fix the electron kinetics must be determined. It is shown that radiation is not essential in such a distribution. During the development of high-frequency oscillations in a plasma, the electron distribution function undergoes a transformation that is associated with electron scattering by field pulsations. This departure of the distribution function from equilibrium may be the cause of a specific nonequilibrium character of the energy distribution of excited atoms. This connection may serve as a channel for energy transfer from the oscillations to nonequilibrium of atom distributions in the region of discrete spectral states. (tr-auth)

22039 RELAXATION OF MAGNETOHYDRODYNAMIC WAVE SPECTRUM IN WEAKLY TURBULENT PLASMA. Aleksin, V. F.; Pavlenko, V. P.; Khodusov, V. D. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 8, 1288-92(Aug 1971). (In Russian).

In the approximation of infinite plasma, described by the ideal magnetohydrodynamics equations, the relaxation of the magnetohydrodynamic wave spectrum is studied, taking into account the three-plasmon processes. Possible channels of nonlinear wave interaction in the relaxation process are determined and typical relaxation times are estimated. (auth)

22040 STIMULATED COMBINATIONAL SCATTERING OF A TRANSVERSE WAVE IN A PLASMA LAYER. Kol'chugina, I. A.; Litvak, A. G. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 9, 1326-30(1971). (In Russian).

The decay interaction of electromagnetic and plasma waves in a homogeneous plasma stab is considered. The characteristics of the interaction, in the case of the amplification and generation of a plasma wave, are determined. The possibility of the experimental observation of the effect is estimated. (auth)

22041 SECOND HARMONIC GENERATION AND EMISSION AT NORMAL INCIDENCE OF AN ELECTROMAGNETIC WAVE ON AN INHOMOGENEOUS MAGNETOACTIVE PLASMA LAYER. Demchenko, V. V.; Dolgopolov, V. V.; Omel'chenko, A. Ya. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 9, 1321-5(1971). (In Russian).

The second harmonic radiation from the plasma (hybrid) resonance region is investigated for the normal incidence of an electromagnetic wave on an inhomogeneous magneto-active plasma layer. Expressions are derived for the field and energy flux density of the second harmonic. It is shown that, as in the case of the isotropic medium, the second harmonic is present only in the reflected wave, the field of the second harmonic being proportional to the first power of the external magnetic field intensity. (auth)

22042 QUASI-STATIC SURFACE WAVES AT THE BOUNDARY OF MAXWELLIAN PLASMA WITH DIFFUSIVE REFLECTION OF ELECTRONS. Rezvov, A. V. (Gorky Scientific-Research Physi-

cal-Technical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 9, 1315-20(1971). (In Russian).

Weakly attenuating quasi-static surface waves are considered in the frame of the kinetic theory of electromagnetic oscillations of the semi-bounded plasma with a pure diffuse reflection of particles by the surface. The given types of oscillations exist in the frequency interval $\omega_p/\sqrt{2} < \omega < \omega_p$, where ω_p is the plasma frequency, which is considerably more than the effective frequency of plasma particle collisions. Consideration is made on the example of Maxwell's distribution of particle velocities, but all the given relations are valid for any system with the Fermi statistics. (auth)

22043 NONLINEAR THEORY OF EXCITATION OF STEADY-STATE OSCILLATIONS BY A RELATIVISTIC ELECTRON BEAM. Kuriiko, V. I.; Tolstoluzhskii, A. P.; Fainberg, Ya. B. At. Energ. (USSR); 32: No. 2, 137-42(Feb 1972). (In Russian).

The nonlinear nonstationary problem of excitation of quasi-monochromatic plasma oscillations by a relativistic electron beam is considered. Equations are derived for the time dependence of the field amplitude in the case when the flight time is small compared with the characteristic time of growth of the field. The dependence of the increment on amplitude and its maximal value in relation to energy and length of the resonator, as well as the distribution function of the beam, are calculated from these equations. (auth)

22044 HIGHER ORDER HARMONIC RESONANCE OF ELECTRONS WITH ELECTROMAGNETIC WAVES PROPAGATING THROUGH MAGNETOPLASMA. Nath, Omkar; Singh, R. N. (Banaras Hindu Univ., India). Plasma Phys.; 13: No. 11, 1027-32(Nov 1971).

The effect of higher-order cyclotron harmonic resonance of electrons with the propagating electromagnetic wave through the magnetoplasma is considered. It is shown that the synchronous energy gain for m = 1 and n = 1 becomes oscillatory at higher harmonics (m ≠ 1, n = D). The expressions for the time period of energy oscillation and maximum energy gain during an oscillation are derived. The nature of the pseudopotential, maximum energy gain, and the time period of energy oscillations are shown graphically. (auth)

22045 NUMERICAL STUDY OF THE PLASMA SCATTERING CROSS SECTION OF AN ELECTROMAGNETIC WAVE IN A DIRECTION NEARLY PERPENDICULAR TO THE APPLIED MAGNETIC FIELD. Meyer, Rene-Luc; Leclert, Gerard; Louet, Catherine (Laboratoire de Physique des Milieux Ionises, Nancy). Plasma Phys.; 13: No. 11, 1051-7(Nov 1971).

The scattering cross section of an electromagnetic wave by a collisionless plasma in a uniform external magnetic field B_0 is computed for the case in which the wave vector k is almost perpendicular to B_0. Values of applied external magnetic field B_0 and of angle θ between k and B_0 that lead to greatest amplitude modulation with maxima at the harmonics of the electron gyrofrequency are considered. These results are useful for planning experiments aimed at observing the cyclotron modulation of the scattered spectrum. (auth)

22046 EFFECTS OF CYLINDRICAL GEOMETRY ON NORMAL IONIZING SHOCK WAVES. Blackburn, T. R.; Brennan, M. H. (Flinders Univ. of South Australia, Bedford Park). Aust. J. Phys.; 24: No. 6, 925-8(Dec 1971).

Except for small electrode separations the shock speed is proportional to the product of the average azimuthal drive field and the axial magnetic field for an ionizing shock produced by an approximately square current pulse of up to 40 kA, with axial magnetic field up to 8 kG in H_2 initially at 150 mtorr. This verifies that the average azimuthal drive field is valid for cylindrical shocks. For coaxial configurations with electrode spacing <2 cm, the measured shock velocity was much less than predicted, presumably because of the increasing influence of boundary layer effects for small separations. (Australia)

22047 STATIONARY COLLISIONAL SHOCKS IN A Q-DEVICE WITH A HOMOGENEOUS MAGNETIC FIELD. Bartoli, C.; Bitter, M. Plasma Phys.; 13: No. 11, 1075-8(Nov 1971).

Stationary collisional shocks were produced in a Q device, using an experimental arrangement allowing continuous variation of Mach number. Results concerning the characteristic scale length of collisional shocks perpendicular to the magnetic field are presented, and variations of the shock thickness with Mach number and density are discussed. (UK)

22048 STABILITY OF BERNSTEIN-GREENE-KRUSKAL WAVE WITH SMALL FRACTION OF TRAPPED ELECTRONS. Wong, H. Vernon (Univ. of Texas, Austin). Phys. Fluids; 15: No. 4, 632-46(Apr 1972).

For $\omega \gg \omega_B = (k|e\phi_0/m_e)^{1/2}$, the normal modes are essentially oscillations of the background plasma and these can be made unstable due to coupling to the periodic motion of the trapped electrons with bound frequency ω_b, where $\omega = n\omega_b$ and n is an integer. However, the most unstable waves have frequency $\omega \sim \omega_B$, and in this regime, plasma oscillations with wave number $k + k_0$ and $k - k_0$, where $k \ll k_0$, are coupled; instability is associated with coupling due to resonant and nonresonant interaction with the trapped electrons. If the trapped electron distribution function is monotonically increasing (decreasing) in energy, then the lower (upper) frequency side band with wavenumber $|k| - k_0$ ($|k| + k_0$) is dominant. (auth)

22049 ANOMALOUS REFLECTION AND TRANSMISSION OF CYCLOTRON WAVES. Marsh, J. (Princeton Univ., N. J.). Phys. Fluids; 15: No. 4, 647-56(Apr 1972).

A formalism is developed to describe the propagation along a slowly varying magnetic field of purely transverse cyclotron waves. By an expansion of the coupled set of Vlasov–Maxwell equations, a one-dimensional wave equation is derived, which is applied to the case where the field configuration is a magnetic mirror with small field variation which includes points of cyclotron resonance where the local gyrofrequency is equal to the wave frequency. An investigation is made of the processes whereby particles trapped in the mirror field can cause anomalous transmission and reflection of the wave by a nonlocal mechanism. It is found that the nonlocal processes are most significant when the function which gives the total phase difference observed by a trapped particle on its orbit between the point of damping of the incident wave and that of excitation of the transmitted or reflected wave is stationary with respect to both the energy and magnetic moment of the particle. (auth)

22050 MICROWAVE COMBINATION SCATTERING FROM PLASMA WAVES IN AN ELECTRON BEAM–PLASMA SYSTEM. Bollinger, L. D.; Boehmer, H. (Univ. of Illinois, Urbana). Phys. Fluids; 15: No. 4, 693-9(Apr 1972).

The spatial development of the electron-beam-excited plasma wave spectrum was investigated by determining the wavenumber, amplitude, and frequency by means of incoherent microwave scattering. The angular dependence, relative to the beam direction, of the most unstable wavenumber was determined. In the initial linear growth stage of the plasma waves, the finite beam radius was found to give a constraint on the angular direction in which the plasma waves grow. Furthermore, microwave scattering from the harmonic of the electron plasma wave showed this to be a wave on the beam branch of the dispersion relation. (auth)

22051 FREQUENCY SHIFT DUE TO TRAPPED PARTICLES. Dewar, R. L. (Princeton Univ., N. J.). Phys. Fluids; 15: No. 4, 712-14(Apr 1972).

The time asymptotic distribution functions corresponding to adiabatic and sudden excitation of an electrostatic wave are calculated. These distributions are compared and used to calculate the nonlinear response of the plasma, and Poisson's equation is used to find a nonlinear dispersion relation. (auth)

22052 GENERAL RECURRENCE RELATION FOR USE IN EVALUATING MOMENTS OF THE INTEGRAND OF THE PLASMA DISPERSION FUNCTION. Goodrich, Lewis C.; Durney, Carl H.; Grow, Richard W. (Univ. of Utah, Salt Lake City). Phys. Fluids; 15: No. 4, 715-16(Apr 1972).

A general recurrence relation is derived that allows one to evaluate moments of the integrand of the plasma dispersion function in terms of the plasma dispersion function itself, without the laborious algebraic manipulations that are used otherwise. (auth)

22053 NONLINEAR ILLUMINATION OF A PLANE PLASMA LAYER. Mironov, V. A. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 9, 1450-2(1971). (In Russian).

A supercritical plasma, exhibiting nonlinear interaction with a field, qualitatively resembles a transparent medium, and the depth of penetration of the field increases. The possibility of nonlinear illumination of a plane plasma layer was investigated. The calculated effect apparently occurs during reflection of an electromagnetic wave from a nonhomogeneous layer of more complex geometry. (K.S.W.)

22054 NONLINEAR INTERACTION BETWEEN WAVES IN A PLASMA WITH RANDOM INHOMOGENEITIES. Tamoikin, V. V.; Fainshtein, S. M. (Scientific-Research Radiophysics

Inst., Gorky, USSR). Zh. Eksp. Teor. Fiz.; 62: No. 1, 213-18 (Jan 1972). (In Russian).

Nonlinear interaction between waves in a plasma with random inhomogeneities is considered in the quasi-hydrodynamic approximation. Basic equations are obtained for quantities averaged over the inhomogeneity ensemble. The contracted equations for the amplitudes and phases of the interacting (transverse and longitudinal) waves in an isotropic plasma are investigated in the one-dimensional approximation on the basis of the asymptotic method. (auth)

22055 STIMULATED WAVE SCATTERING IN A MAGNETO-ACTIVE PLASMA. Litvak, A. G.; Trakhtengerts, V. Yu. (Scientific-Research Radiophysics Inst., Gorky, USSR). Zh. Eksp. Teor. Fiz.; 62: No. 1, 228-32(Jan 1972). (In Russian).

Some features of stimulated scattering of monochromatic electromagnetic waves in a magneto-active plasma are considered. Expressions are obtained for the scattering increments in the hydrodynamic stage. The possibility of employing the processes considered for diagnostics and heating of a plasma is discussed. (auth)

22056 EXCITATION OF LONGITUDINAL ELECTROMAGNETIC WAVES IN A RESTRICTED PLASMA BY INJECTION OF RELATIVISTIC ELECTRON BEAMS. Bogdankevich, L. S.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 233-46(Jan 1972). (In Russian).

A detailed analysis of the nature and conditions of excitation of longitudinal electromagnetic waves in a spatially restricted magnetoactive plasma by a low-density electron beam is presented. The increments, frequency spectra, and widths of spectra excited by a plasma wave beam are determined. Nonlinear estimates of the maximal amplitudes of stationary oscillations are presented. The results obtained are discussed (1) from the viewpoint of the possibility of using intense relativistic electron beams for excitation of high-amplitude plasma waves and (2) for the case of probing the Earth's ionosphere by a low-intensity relativistic electron beam. (auth)

22057 BUILD-UP OF LOW FREQUENCY POTENTIAL OSCILLATIONS IN A COLD MAGNETOACTIVE PLASMA BY THE FIELD OF AN ELECTROMAGNETIC WAVE. Pustovalov, V. V.; Romanov, A. B. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 253-9(Jan 1972). (In Russian).

Solutions of the dispersion equation for potential oscillations of a magnetoactive plasma located in the field of a plane high-frequency electromagnetic wave are investigated for frequencies less than, or comparable to, the ion gyroscopic frequency. The maximal increments and minimal threshold fields determined by the collision frequency between charged and neutral particles are found in the case of weak coupling between the wave and plasma perturbations. The directions of propagation of unstable potential oscillations are determined for which the increments are maximal. In the case of strong coupling, the instability is a periodical. (auth)

22058 EXPLOSIVE INSTABILITY OF INTEREST IN COLLISIONLESS SHOCKS. Boyd, T. J. M.; Turner, J. G. (University Coll. of North Wales, Bangor). Phys. Lett.; 38A: No. 3, 155-6(31 Jan 1972).

The Lagrangian approach to wave–wave interactions is used to estimate the growth rate for the explosive interaction of a negative energy Bernstein wave and two ion acoustic waves that may be relevant in collisionless shock studies. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 21054, 21279, and 21403.

22059 INTERACTION OF 25-keV ELECTRONS WITH THE NUCLEIC ACID BASES, ADENINE, THYMINE, AND URACIL. I. OUTER-SHELL EXCITATION. Isaacson, Michael (Univ. of Chicago). J. Chem. Phys.; 56: No. 5, 1803-12(1 Mar 1972).

The energy-loss functions—$\mathrm{Im}(1/\epsilon)$ of thin films of the nucleic acid bases, adenine ($C_5N_5H_5$), thymine ($C_5N_2O_2H_6$), and uracil ($C_4N_2O_2H_4$) were determined in the range 2 to 50 eV from energy-loss experiments with 25-keV electrons at room temperature. An analysis of the electronic structure of these materials in the region of outer-shell excitation was obtained in the form of determination of the dielectric constants ϵ_1 and ϵ_2 from a Kramers–Kronig analysis of the energy-loss function. In the spectral region where ultraviolet absorption data exists (<10 eV), the calculated optical absorption coefficient μ is shown to be in good agreement with the optical measurements. (auth)

22060 INTERACTION OF 25-keV ELECTRONS WITH THE NUCLEIC ACID BASES, ADENINE, THYMINE, AND URACIL. II. INNER-SHELL EXCITATION AND INELASTIC SCATTERING CROSS SECTIONS. Isaacson, Michael (Univ. of Chicago). J. Chem. Phys.; 56: No. 5, 1813-18(1 Mar 1972).

The energy-loss spectra of 25-keV electrons traversing thin films of the nucleic acid bases adenine ($C_5N_5H_5$), thymine ($C_5N_2O_2H_6$), and uracil ($C_4N_2O_2H_4$) were obtained at room temperature in the region of K-shell excitation (>285 eV), and fine structure near the carbon K edge of these materials was analyzed. The inelastic scattering cross sections were also determined for both K-shell and valence-shell excitation. Preliminary results on the effect of electron beam damage of these specimens will also be presented. (auth)

22061 VAVILOV–CHERENKOV RADIATION OF AN ELECTRIC CHARGE IN A UNIAXIAL GYROTROPIC CRYSTAL. Kuk Kukanov, A. B.; Orisa, B. D. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 2, 159-60(Aug 1971).

Translated from Opt. Spektrosk.; 31: No. 2, 299-301(Aug 1971).

Results are presented of integrations of the Cherenkov radiation intensity equations for cases in which the charged particle passes perpendicularly to the optic axis of a uniaxial gyrotropic crystal. In the transition of the results to the case of an isotropic medium, agreement with the classical results is obtained. (D.L.C.)

22062 ELECTRON–ELECTRON BREMSSTRAHLUNG AT 300 keV FROM A KINEMATICALLY OVERDETERMINED MEASUREMENT. Nakel, W.; Pankau, E. (Univ., Tuebingen, Ger.). Phys. Lett.; 38A: No. 5, 307-8(28 Feb 1972).

The elementary processes of electron–electron bremsstrahlung and electron–nucleus bremsstrahlung were differentiated by means of a kinematically overdetermined measurement. Electrons of 300 keV are used, which were incident on a carbon target. (auth)

22063 INELASTIC SCATTERING OF ELECTRONS IN A SOLID BY EXCITATION OF DEEP ATOMIC LEVELS. I. ENERGY LOSS SPECTRA. Colliex, C.; Jouffrey, B. (CNRS, Orsay, France). Phil. Mag.; 25: No. 2, 491-511(Feb 1972). (In French).

The inelastic scattering of fast electrons caused by excitation of deep atomic electrons was studied experimentally with an electron microscope equipped with a Castaing–Henry energy filter. The contribution of these excitations to the energy-loss spectrum is considered and it is shown how the observed structures can be related to the density-of-states curves, which possess a given symmetry. The similarity between energy loss and x-ray absorption measurements is emphasized. The angular distribution of electrons having suffered such a scattering process and the mean free path for the excitation of a deep electron were measured. These results can be interpreted to a first approximation within a simple model of scattering by an isolated atom. (auth)

22064 SPATIAL DOSE DISTRIBUTION VISUALIZATION IN A HIGH POWER PULSED BEAM OF FAST ELECTRONS. Vagin, Yu. P.; Kabanov, G. L.; Medvedev, Yu. A.; Stepanov, B. M. At. Energ. (USSR); 32: No. 1, 73-5(Jan 1972). (In Russian).

Visualization of electron scatter by means of fluorescence was accomplished with 4- and 1-MeV electron beams (0.1 and 3 A, respectively). Illumination of the air was observed in a volume of about 1 cm^3 located in the inner cavity of a Faraday cylinder, and was photographed for further quantitative evaluation. The results of three different methods agreed with one another, and it is concluded that dose measurement in electron beams may be achieved by photographically recording the field of illumination. (K.S.W.)

22065 INELASTIC COLLISIONS IN THE TOWNSEND–HUXLEY DIFFUSION EXPERIMENT. Francey, J. L. A.; Stewart, P. K. (Monash Univ., Clayton, Australia). Aust. J. Phys.; 24: No. 6, 841-6(Dec 1971).

The Boltzmann equation, including density gradients, is solved for the electron distribution function in the Townsend–Huxley experiment. Elastic and inelastic collisions with constant cross sections are assumed to occur, the inelastic energy loss per collision being small compared with the mean energy. The inelastic energy loss and the electron mean energy are calculated and tabulated over a range of values of E/P. (auth)

22066 VALIDITY OF THE TWO-TERM APPROXIMATION OF THE ELECTRON DISTRIBUTION FUNCTION. Robson, R. E.; Kumar, Kailash (Australian National Univ., Canberra). Aust. J. Phys.; 24: No. 6, 835-40(Dec 1971).

The Boltzmann equation for electrons moving in a neutral gas under the influence of an externally applied field is solved by expanding the electron distribution function in terms of Legendre and Sonine polynomials. The solution is given in terms of infinite matrices which have elements ordered by the Sonine polynomial index, and which are dependent upon the field strength. From the structure of the formulas, it is possible to infer that truncation of the Legendre polynomial expansion after two terms is a good approximation at all field strengths. This is supported by calculations of the electron drift velocity at low field strengths, which show that the error introduced by making the two-term approximation is small, even when the deviation from equilibrium is significant. The convergence of the Sonine polynomial expansion is shown to be strongly dependent upon field strength, and large matrices are required in the drift velocity formula at even small field strengths. (auth)

22067 STOPPING POWER OF CRYSTALS FOR INELASTIC COLLISIONS WITH OSCILLATORY DEPENDENCE ON ION CHARGE. Kessel'man, V. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 8, 1346-52(Feb 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 8, 1708-16(Aug 1971).

By using the independent-particle nuclear model for the atom, an equation for the stopping power is derived for inelastic collisions with oscillatory dependence of the order of the ion. (auth)

Radiation Protection Standards

22068 (BRH/DEP-72-4) MEASUREMENT OF ELECTROMAGNETIC RADIATION LEVELS FROM SELECTED TRANSMITTERS OPERATING BETWEEN 54 AND 220 MHz IN THE LAS VEGAS, NEVADA, AREA. Envall, Kenneth R.; Peterson, Richard W.; Stewart, Harold F. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Sep 1971. 84p. GPO $0.75.

Electromagnetic power levels were measured and compared with theoretical power levels from selected transmitters operating in the frequency range of 54 to 220 MHz in the Las Vegas, Nevada, area. The field measurements were made at 62 grid locations by means of calibrated dipole and biconical antennas. Power variations with respect to antenna height, time of day, distance from a grid point, angular dependence, and terrain were investigated. The data were evaluated in terms of observed and theoretical power levels and converted to power densities for hazards analysis applications. The results indicate that estimates of theoretical power levels should serve as a satisfactory measure of population exposure to electromagnetic energy in the frequency range considered. (auth)

22069 (ORNL-TM-3396) NUCLEAR WEAPONS FREE-FIELD ENVIRONMENT RECOMMENDED FOR INITIAL RADIATION SHIELDING CALCULATIONS. Auxier, J. A.; Burson, Z. G.; French, R. L.; Haywood, F. F.; Mooney, L. G.; Straker, E. A. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 50p. Dep. NTIS.

A review of the individual components of the initial nuclear radiation field from an intermediate-yield thermonuclear weapon is presented. The purpose was to develop criteria for use in determining initial radiation protection or dose-transmission factors for civil defense structures. Parameters investigated

included energy and angular distributions of neutrons and gamma rays at the source as well as those incident on the shield; transmission of neutrons and gamma rays through shielding material; triple point overpressure as a function of angle of incidence at the point of interest; and dose as a function of distance, weapon yield, and overpressure. Data are presented for the above parameters. In addition, the recommended criteria for calculating initial radiation protection or dose transmission factors are given. (auth)

PHYSICS (SOLID-STATE)

Refer also to abstracts 22069, 22189, 22371, and 22406.

22070 ANNUAL REVIEW OF MATERIALS SCIENCE. VOLUME 1. Huggins, Robert A. (ed.). Palo Alto, Calif.; Annual Reviews, Inc. (1971). 427p. $10.00.

Twelve articles are included; separate abstracts were prepared for five of them. The topics of the articles not abstracted are: structural characterization by electron microscopy and spectroscopy, theoretical techniques, models of structures of ideal clean solid surfaces, solid-state phase transformations, solid thin films, strengthening mechanisms in crystalline solids, and electronic and optical phenomena in semiconductors. Author and subject indexes are included. (D.L.C.)

For abstracts of individual papers see: 22085, 20724, 20781, 22121, and 22122.

Radiation Effects

Refer also to abstracts 20081, 20118, 20137, 20523, 20938, and 21011.

22071 (AECL–4069) ELECTRON CHANNELLING PATTERNS IN SCANNING ELECTRON MICROSCOPY. II. RAPID ASSESSMENT OF CRYSTAL SURFACES. Schulson, E. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Dec 1971. 24p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

The quality of electron channeling patterns (i.e., the angular width and contrast of individual channeling lines) is a measure of the degree of perfection of crystalline surfaces. Considered are Bragg diffraction and electron optical factors limiting pattern quality from good crystals, methods of quantitatively measuring changes accompanying surface degradation, and the effects on pattern quality of mechanical polishing, ion implantation damage in semiconductors, and surface films. Pattern degradation is assessed in terms of channeling line broadening leading to a lattice rotation parameter $\bar{\phi}$ and in terms of a contrast reduction parameter, R. The rotation parameter can be analyzed in terms of lattice defects, and is expected to be sufficiently sensitive to detect lattice misorientations as small as 0.05°. The contrast reduction parameter, on the other hand, is simply a qualitative parameter. The work shows that the electron channeling pattern technique is a rapid and nondestructive method for examining crystal surfaces. (auth)

22072 (CEA-N–1501) ELECTRON MICROSCOPE STUDY OF FISSION FRAGMENT IRRADIATED Au. Masounave-Bounahoum, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec 1971. 46p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France). Faculte des Sciences.

Thin Au foils, suitable for transmission electron microscopy, were irradiated at room temperature with fission fragments. The energies and fluences of the irradiating particles were varied, and the cluster density was measured as a function of these two parameters; it was possible to distinguish the effects of two types of fission fragments: light and heavy. The average light fission fragment produced 30 visible clusters and the average heavy fission fragment produced 50 visible clusters. The results are compared with calculations made using the theory of Lindhard. The threshold energy that must be transmitted to a primary atom for it to leave a visible cluster was measured. (France)

22073 (COO–3158-4) DEFECTS IN METAL CRYSTALS. Annual Progress Report. Balluffi, R. W.; Seidman, David N. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). Jan 1972. Contract AT(11-1)-3158. 27p. Dep. NTIS.

Progress was made in the following areas: (a) field ion microscope (FIM) and electrical resistivity study of vacancy defects in platinum; (b) FIM and electrical resistivity study of vacancy defects in tungsten; (c) in-situ FIM studies of defects in platinum irradiated with platinum ions; (d) in-situ FIM studies of defects in tungsten irradiated with tungsten ions; (e) in-situ FIM studies of gold irradiated with gold ions and the field ion microscopy of gold; (f) computer simulation of contrast effects produced by defects in FIM specimens; (g) contrast patterns produced by self-interstitial atoms in FIM images of a bcc metal; (h) void formation in quenched or irradiated metals; (i) electron microscope studies of low- and high-angle grain boundaries; (j) grain-boundary dislocation climb in irradiated gold bicrystals; (k) FIM studies of solute atoms in dilute platinum alloys; (l) construction of an atom probe FIM; and (m) construction of an FIM specimen tip developer. (auth)

22074 (COO–3171-2) EFFECT OF ELECTRON IRRADIATION ON VOID FORMATION IN HELIUM PREINJECTED ALUMINUM FILMS. Rao, P.; Glowinski, L. D.; Ho, P. S. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 3 Jan 1972. Contract AT(11-1)-3171. 29p. Dep. NTIS.

The effect of 200-kV electron irradiation on evaporated aluminum films preinjected with 35-keV helium ions was studied. With a dose, above the threshold level, of 100 ppM or 1×10^{15} ions/cm^2 of helium, the damage produced consisted of voids 30 to 40 Å in diameter and dislocation loops 200 Å in diameter. Such damage was observed to be enhanced by in-situ electron irradiation at room temperature (0.3 T_m) with a dose rate of 1×10^{19} electrons/cm^2-sec. The enhancement was in the form of increased void number density and void volume, in addition to increased interstitial dislocation loop density and loop area. This effect appeared to be temperature-dependent, since a decrease in void volume with a smaller increase in interstitial dislocation loop area was observed on electron irradiation at 100°C (0.4 T_m). The annealing of helium preinjected films, prior to electron irradiation, at 100°C resulted in a large increase in void volume accompanied by a slight decrease in dislocation loop number density and loop area although loop size increased. Interstitial loops play an important role in void formation. The preferential removal of interstitials at these loops tends to reduce recombination of interstitials and vacancies produced by electron irradiation, thus creating a sufficient vacancy supersaturation to promote void growth. Positive identification of voids 30 to 40 Å in diameter in aluminum was made using recently developed electron microscope techniques. This includes the use of "through-the-focus" sequences of micrographs to determine change in void contrast. (auth)

22075 (KFKI–71-71) V-CENTER PRODUCTION IN POSITRON ANNIHILATION. Hrasko, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1971]. 4p. Dep. NTIS (U. S. Sales Only).

It is assumed that positron annihilation in ionic crystals is accompanied by V-center production. This leads to a definite smooth dependence of the parameters of the lifetime spectra on the number of annihilations. (auth)

22076 (ORO–3912-15) COMPUTER EXPERIMENT STUDIES ON MECHANISMS FOR IRRADIATION INDUCED DEFECT PRODUCTION AND ANNEALING PROCESSES. Progress Report, June 1, 1969–December 31, 1971. Beeler, J. R. Jr. (North Carolina State Univ., Raleigh). Feb 1972. Contract AT(40-1)-3912. 25p. Dep. NTIS.

Progress is reported in the following areas: high-temperature annealing; effects of impurities on void nucleation and growth; interactions of point defects with dislocations, free surfaces, grain boundaries, and precipitate interfaces; dislocation dynamics calculations; characterization of saturated damage states; effect of hydrostatic pressure and uniaxial stress on defect behavior; and computer program development. (D.L.C.)

22077 (ORO–4049-2) RADIATION DAMAGE IN OPTICALLY TRANSPARENT MATERIALS (ZIRCONS). Progress Report, February 1, 1971–January 31, 1972. Thorpe, A. N.; Wasilewski, P. J.; Sullivan, S.; Senftle, F. E. (Howard Univ., Washington, D. C.). Contract AT(40-1)-4049. 12p. Dep. NTIS.

Radiation damage in natural zircon caused by α-particle recoil of the parent uranium nucleus results in a shift of the infrared band of SiO_2 from 11 to 9.7 μm, and also a decrease in the infrared transmission at 5.9 to 6.0 μm. A linear relation is found between the absorption coefficient at 5.9 to 6.0 μm and the radiation dose. After annealing at 950°C for 20 hours, the same specimens showed a smaller change in the absorption coefficient with radiation damage, indicating a partial recovery of the damaged specimens. Magnetic susceptibility studies show a linear change in susceptibility with the iron concentration and corresponds to a magnetic moment $\mu = 4.92\ \mu_B$, the moment of orbitally quenched ferrous iron. No relation was found between magnetic moment and total alpha dose. Infrared measurements indicate the ferrous iron is in octahedral coordination. Radiation damage may be expected to distort the ligand field about the iron ion. Over a wide temperature range, the experimental data are in good agreement with calculated values based on a spin Hamiltonian for tetragonal geometry. The zero-field splitting terms, from the spin Hamiltonian, appear to be related to the total α-radiation dose. To

further examine the damage, high-voltage (1 MeV) electron microscopy is currently being used on very thin plates of zircon covering the entire range of α-radiation damage. (auth)

22078 . MASS-SPECTROMETRIC STUDY OF SPUTTERING OF KBr BY LOW-ENERGY Ar^+ AND Xe^+ IONS. Campbell III, Arthur B.; Cooper, C. Burleigh (Univ. of Delaware, Newark). J. Appl. Phys.; 43: No. 3, 863-6(Mar 1972).

A KBr target was bombarded normally with Ar^+ and Xe^+ ions, with energies ranging from 25 to 180 eV, in the source of a mass spectrometer capable of detecting neutral and negative sputtered species. A relatively strong signal of Br^- ions sputtered from the target was detected, and relative sputtering yield curves were obtained. The yield was greater for Ar^+ than for Xe^+ ion bombardment at all ion energies. No neutral K^0 or Br^0 atoms, nor KBr^0 molecules, were detected as having been sputtered from the target during bombardment. (auth)

22079 Mg- AND Be-ION-IMPLANTED GaAs. Hunsperger, R. G.; Wilson, R. G.; Jamba, D. M. (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys.; 43: No. 3, 1318-19(Mar 1972).

The p-type layers were produced in GaAs by implantation of either Mg or Be ions, with the substrate at room temperature, followed by annealing at higher temperatures. The ion source in both cases was a hot-cathode electron-bombardment type. The Mg ions were generated by placing metallic Mg in an axial probe inserted into the source, while the Be ions were produced by placing $BeCl_2$ in the probe. n-type ⟨111⟩ substrates were implanted with 45-keV Mg or 40-keV Be ions, and were subsequently annealed for 15 min at temperatures up to 900°C. The dependence of surface carrier concentration and mobility on ion dose and on post-implantation anneal temperatures was determined using the van der Pauw-Hall technique. (auth)

22080 ENHANCED ANNEALING EFFECTS IN BORON-IMPLANTED LAYERS IN SILICON BY POSTIMPLANTATION OF SILICON IONS. Bauer, L.-O. (Hughes Aircraft Co., Newport Beach, Calif.). Appl. Phys. Lett.; 20: No. 3, 107-9(1 Feb 1972).

Various effects of post implantation of silicon ions on boron-implanted layers are reported. The amount of enhanced annealing depends critically on the target temperature during implantation and on the dose of silicon ions used. At 100 keV, a $5 \times 10^{15}/cm^2$ silicon dose is necessary to create an amorphous layer extending up to the surface at room temperature. Close to 100% of the boron ions located in this layer become electrically active after annealing at 600°C. For boron doses approximately greater than $3 \times 10^{15}/cm^2$, shallow silicon implantations produce stronger enhanced annealing than expected. For boron doses less than $2 \times 10^{14}/cm^2$, little or no enhanced annealing is observed. (auth)

22081 EFFECTS OF AN ION BOMBARDMENT ON THE CHARACTERISTICS OF A METAL/n-GaAs TUNNEL CONTACT. Guetin, P.; Schreder, G. (Laboratoires d'Electronique et de Physique Appliquee, Brevannes, France). J. Appl. Phys.; 43: No. 2, 549-61(Feb 1972).

Gallium arsenide surfaces were submitted to low-energy ion bombardment. Metal/n-GaAs tunnel contacts realized on the surfaces prepared in this manner present features that depend greatly on the ion energy. At very low energy (50 eV), gas ions provide a "cleaning" of the interface and yield tunnel characteristics essentially identical to those of a vacuum-cleaved analogous contact. This technique may be used to define the origin of tunneling anomalies. Higher-energy bombardments (100 to 150 eV) lead to strong changes of the tunnel properties that can be summarized as a large resistance increase in spite of a strong barrier lowering and the appearance of inelastic processes. A model based on the creation of structural defects accounts qualitatively for all of the observed phenomena. Tunneling represents, therefore, a promising technique in the study of very-low-energy ion bombardments. (auth)

22082 EPR STUDIES OF Ti^{3+}-H^+ CENTERS IN X-IRRADIATED α-QUARTZ. Rinneberg, H.; Weil, J. A. (Argonne National Lab., Ill.). J. Chem. Phys.; 56: No. 5, 2019-28(1 Mar 1972).

Two titanium centers (A-Ti-H and B-Ti-H) are formed in equal concentrations by reaction of hydrogen atoms with Ti^{4+} in the α-quartz lattice at 120°K. Above 150°K, B-Ti-H transforms into A-Ti-H. The spin Hamiltonians, including $^{47,49}Ti$ hyperfine and nuclear quadrupole terms, have been determined by 9.850-GHz EPR at 20°K for both centers. These data, discussed from a crystal-field viewpoint and compared with results for analogous lithium-compensated Ti^{3+} centers, lead to a model for the centers involving a substitutional Ti^{3+} ion with a nearby interstitial proton charge compensator located in either of two different sites. (auth)

22083 MEASUREMENT OF CARRIER LIFETIMES IN GERMANIUM AFTER IRRADIATION WITH 14-MeV NEUTRONS. Detasch, H.-D; Roose, U. (Univ., Kiel). Atomkernenergie; 19: No. 1, 71-4(1972). (In German).

Resistance and carrier lifetime measurements were made on Sb-doped germanium in the temperature range from 77 to 300°K. Materials with resistivities between 8 and 25 ohm-cm were investigated. Carrier lifetime was determined from photoconductivity decay. Measurements were made at low excess-carrier densities. Exponential photodecay appeared from 300 to 250°K because of a recombination center ($E_c - 0.2$ eV) in the upper band. At low temperatures, below 200°K, there was a superposition of two exponentials induced by the recombination level in the upper and a trap in the lower half of the forbidden band. Isochronous annealing from 77 to 450°K after 14 MeV neutron irradiation shows a recovery step at 160°K (illuminated specimen). This is explained as breakup of clusters. A peak of inverse annealing near room temperature may be interpreted by formation and breaking of Sb-vacancy complexes. (auth)

22084 ANISOTROPY OF THE THRESHOLD ENERGY FOR THE PRODUCTION OF FRENKEL PAIRS IN TANTALUM. Jung, Peter; Schilling, Werner (Kernforschungsanlage, Juelich, Ger.). Phys. Rev., B; 5: No. 6, 2046-56(15 Mar 1972).

Thin tantalum single-crystal foils with the ⟨110⟩ direction normal to the surface were irradiated with electrons of energies between 1.0 to 3.2 MeV. By varying the orientation of the foil relative to the direction of the beam over a major part of the fundamental triangle, a strong directional effect in the damage rate was observed for transferred energies of more than 36 eV. In previous measurements especially on the fcc metals copper and gold, much less, if any, anisotropy of the defect production was observed. The data were corrected for beam spreading due to the finite sample thickness. From the dependence of the defect production on electron energy and foil orientation, the angular dependence of the threshold displacement energy could be fitted. Good overall fits were only possible when the averaged threshold was about 36 eV in a region of 20° around the ⟨111⟩ direction, about 53 eV in a region of 18° around the ⟨100⟩ direction, and larger than 130 eV in other directions. The existence of such "windows" along the close-packed directions indicates a sequence of replacement collisions which eventually leads to a stable defect. Computer calculations by the Brookhaven group for bcc iron yielded similar threshold windows around the principal crystallographic directions. However, the ratio of the threshold values for the ⟨100⟩ and ⟨111⟩ directions obtained by this group does not agree with the result. For the lowest threshold energy in tantalum, 32 ± 2 eV was found, and for the electrical resistivity per unity concentration of Frenkel pairs, $(17 \pm 3) \times 10^{-4}$ Ω cm was obtained. (auth)

22085 STRUCTURE OF DEFECTS IN SOLIDS. Crawford, J. H. Jr.; Slifkin, L. M. (Univ. of North Carolina, Chapel Hill). Contracts AT(40-1)-3677; AT(40-1)-2036. Annu. Rev. Mater. Sci.; 1: 139-64(1971).

The emphasis of this review is on point defects. Ion transport in simple halides is discussed, and new mechanisms of diffusion in metals are considered. The behavior of composite (complex) defects in nonmetals and the use of ionic thermocurrents to study them are described. Progress on motion of ions induced by photon absorption is summarized. The variety of information on defect properties that can be obtained from dislocation loops is displayed. Finally, recent results on radiation defects in semiconductors are summarized. 118 references. (D.L.C.)

22086 BOUND STATES OF SWIFT NEGATIVE PARTICLES IN CRYSTALS. Bell, F.; Kreiner, H. J.; Sizmann, R. (Univ., Munich). Phys. Lett.; 38A: No. 5, 373-4(28 Feb 1972).

It is shown that the continuum approach for negative-particle channeling in crystalline solids comprises a bound motion. The lifetimes of these bound states are limited by the influence of thermal lattice vibrations on the penetrating projectile. (auth)

22087 NEUTRON IRRADIATION DAMAGE IN SiC WHISKERS. Stevens, R. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Phil. Mag.; 25: No. 2, 523-8(Feb 1972).

Radiation damage in SiC whiskers was observed using transmission electron microscopy. Damage was apparent as spots up to 5 nm diameter at neutron doses in excess of 2×10^{20} nvt ≥ 0.18 MeV. At the highest dose employed ($\sim 1.2 \times 10^{21}$ nvt ≥ 0.18 MeV), agglomeration of defects appeared to have taken place. Further evidence for defect condensation was obtained on examination of vacuum-annealed irradiated whiskers, when dislocation loops lying on {111} were observed. (auth) (UK)

22088 X-RAY-INDUCED VARIATION OF TIME CONSTANT OF Yb^{+3} SENSITIZER. Hersh, H. N.; Ban, G. (Zenith Radio Corp. Labs., Chicago). Appl. Phys. Lett.; 20: No. 3, 101-2 (1 Feb 1972).

A unique method is described for continuously and independently varying the rate-controlling time constant of excited Yb^{+3} ions in rare-earth up-converting phosphors. It is shown in the system $BaYb_2F_8$: Er that, at all values of the time constant, the power radiated is directly proportional to the square of the observed radiative lifetime, in accordance with the 2-transfer model of Auzel. The decrease in this time constant arises from the introduction of radiation-produced defects which selectively affect the Yb^{+3} rather than the activator ions. The phenomenon can be used to study energy transfer from Yb^{+3} to any activator. (auth)

22089 RADICAL IN GAMMA IRRADIATED KH_2PO_4. Abe, Ryuji; Naito, Masataka (Toyoda Physical and Chemical Research Inst., Nagoya, Japan). Toyoda Kenkyu Hokoku; No. 24, 1-4(Mar 1971). (In Japanese).

In order to know the structure of the defect which had an important effect on the dielectric constant of KDP(KH_2PO_4), the ESR spectra of γ irradiated KDP were examined. The spectrum of the radical formed by γ irradiation did not disappear in a short time even at 160°K, as previously reported by Hughes et al. Furthermore, the spectrum of the radical changes around the Curie point (123°K). Some discussions on the structure of the radical are presented. (auth) (Japan)

22090 RECOMBINATION LUMINESCENCE YIELDS IN CHLORIDES OF SODIUM AND POTASSIUM. Mochenov, M. I.; Avdonin, V. P.; Plachenov, B. T. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 10, 1509-11(Jul 1971). (In Russian).

The yield of activator recombination luminescence which results from the disruption by light of F centers in irradiated crystals NaCl–Ag was investigated. The total yield remained constant over the range 77 to 340°K. The effectiveness of F-center generation by β particles was determined using ^{90}Sr–^{90}Y source at room temperature. The yield amounted to 0.2 F-center per 100 eV. (K.S.W.)

22091 INFLUENCE OF LIGHT ON DISLOCATION MOBILITY IN γ-IRRADIATED ALKALI METAL HALIDE CRYSTALS. Ermakov, G. A.; Nadgornyi, E. M. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 7, 1422-4(Jul 1971). (In Russian).

The effect of light on the velocity of movement of individual screw (Burgers) dislocations was studied in γ-irradiated KCl and NaCl. The velocity of dislocations was observed to change in the presence of light, a phenomenon called "photomobility of dislocations," in analogy to photoconductivity. (K.S.W.)

22092 HIGH-FREQUENCY LOCAL OSCILLATIONS IN LiF CRYSTALS WITH HYDROGEN AND TRITIUM COLOR CENTERS. Akhvlediani, Z. G.; Politov, N. G. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 7, 1414-17(Jul 1971). (In Russian).

Monocrystals of LiF containing different amounts of hydroxyl ions were studied. The presence of OH^- was used to produce hydrogen centers. When the LiF was irradiated with γ rays, three absorption maxima were observed: at 2,200, 2000, and 2,100 cm^{-1}. These bands are interpreted. Tritium color centers may arise during irradiation in a nuclear reactor as a result of the process: $^6Li(n,\alpha)T$. (K.S.W.)

22093 TIME-RESOLVED INVESTIGATIONS OF ENERGY TRANSFER IN Eu^{3+}:Y_2O_3. Koebler, U. (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 250: No. 3, 217-27(1972).

The concentration dependence of the energy transfer from the Eu^{3+} ions at lattice sites of point symmetry C_{3i} to the Eu^{3+} ions at lattice sites of point symmetry C_2 in Y_2O_3 has been investigated by analyzing the nonexponential fluorescence decay curves of the donors measured after excitation by a short optical light pulse. The simple model of a fixed interaction range R_0 proved to be adequate to explain the experimental observations. An interaction range of $R_0 = 8.7$ Å was found in agreement with previous steady-state experiments. (auth)

22094 RADIATION DEFECTS IN CaF_2 CRYSTALS. Zavadovskaya, E. K.; Lisitsyn, V. M.; Ovcharov, A. T.; Fedorov, V. A.; Baranov, A. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 7, 1367-70(Jul 1971). (In Russian).

The production of special radiation defects in CaF_2 by beams of 1.2-MeV electrons or 4.5-MeV protons in doses up to 10^8 rad was investigated. The concentration of the induced defects was measured by optical absorption and decreases in the crystal density. (K.S.W.)

22095 DEPENDENCE OF YIELD OF RADIATION DEFECTS ON THE VOLUME TRANSFER OF ENERGY IN TRACKS AND FREQUENCIES OF OVERLAPPING OF CHARGED PARTICLE TRACKS IN IONIC CRYSTALS. Vaisburd, D. I.; Kravchenko, N. S.; Melikyan, L. A.; Alekseev, P. D. (Tomsk Polytechnic Inst., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 7, 1364-6(Jul 1971). (In Russian).

The dose dependence of the concentration of F centers is characterized by fast and slow phases of the accumulation during irradiation of a crystal both with protons and with x radiation. The linear energy transfer of a particle is only indirectly related to the local density of excitations. Levels of saturation of the fast and slow stages of F-center accumulation in NaCl as a function of proton energy are discussed. (K.S.W.)

22096 KINETICS OF INTERNAL-CENTER LUMINESCENCE OF A CsI CRYSTAL DURING α- AND γ EXCITATIONS IN AN EXTERNAL FIELD. Grigor'ev, V. A.; Obodovskii, I. M.; Runtso, M. F. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 7, 1344-7(Jul 1971). (In Russian).

The temperature dependence of the light sum of the persistences (fading time) of discrete α and γ scintillations in nonactivated CsI was studied. In the case of the α-scintillations, this dependency was readily expressed by one exponent with an activation energy W = 0.084 to 0.086 eV. The external electrical field decreased (quenched) the light sum of the individual scintillations and contracted their durations. These effects were explained by the influence of the electric field immediately at the excited center of luminescence, i.e., by a reduction of the activation energy of thermal quenching W. (tr-auth)

22097 ELECTRON EXCITATION AND IONIC DEFECTS IN ALKALI METAL HALIDE CRYSTALS. Lushchik, Ch. B. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 7, 1305-11(Jul 1971). (In Russian).

The fundamental attainments in research on electron excitation and ionic defects in alkali metal halide crystals are outlined. Problems in relaxed and unrelaxed excitations and the decay of electron excitation to structural defects are discussed. Low-temperature (100°K) relaxation luminescence in KCl and NaCl: Cu as stimulated by 3-eV photons following x irradiation, and by excitation by 8.1-eV photons from 100 to 400°K is examined. A number of unsolved problems in this area are listed. (45 references) (K.S.W.)

22098 SELF-DIFFUSION COEFFICIENT OF Na IN NaCl DURING X-RAY IRRADIATION OF THE SAMPLE. Ruiz Mejia, C. (Univ. Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis.; 20: No. 3, 183-9(1971).

The effect of irradiation in the self-diffusion process of Na in NaCl is considered, using a model for diffusion processes that ignores the crystalline structure of the material. The effect of interstitial clusters present in the sample during the self-diffusion process is to reduce the diffusion particles by absorption of the ions in motion. It was found that this effect can be explained in terms of the number of agglomerates per interstitial, their cross section capture, and the ion velocity. The experimental data are consistent with the model. (auth)

22099 THEORY OF DISLOCATION-CREEP DUE TO THE FRENKEL DEFECTS OR INTERSTITIALCIES PRODUCED BY BOMBARDMENT WITH ENERGETIC PARTICLES. Gittus, J. H. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Phil. Mag.; 25: No. 2, 345-54(Feb 1972).

When a material is subjected to stress while being bombarded with a flux of energetic particles it often creeps at a temperature-independent rate that varies with the product of flux and stress. It is shown that this simple class of behavior is, theoretically, to be expected in materials containing a three-dimensional network of dislocations that absorb interstitials ("I-creep") or interstitials plus vacancies ("F-creep"). The dislocations climb into positions where they can bow out until their curvature produces an opposing force virtually equal to that due to the external stress. From the Mott–Friedel equation for dislocation bowing, the resultant creep strain was calculated and proves to be comparable in magnitude to that measured experimentally. (auth)

22100 SPATIAL DISTRIBUTION OF DEFECTS PRODUCED IN ALKALI HALIDES BY ELECTRON IRRADIATION. Arsenovici, L. C.; Townsend, P. D. (Univ. of Sussex, Eng.). Phil. Mag.; 25: No. 2, 381-95(Feb 1972).

Irradiation of alkali metal halides with 30-kV electrons produces coloration, sputtering, and polygonization of the surface. Bleaching and annealing studies show that there are several types of F centers that give characteristic F bands. It is suggested that movement of anion vacancies results in the development of polygonization lines. The results are interpreted in terms of a model where the different types of F centers are not uniformly distributed throughout the crystal and the first stage (fast coloring) centers are concentrated around the dislocations. (auth)

22101 PHOTOLUMINESCENCE OF ANODIC ZrO_2 LAYERS. Mochniak, J.; Wrzesinska, A. (Higher Pedagogical School, Opole, Poland). Acta Phys. Pol., A41: No. 2, 165-72(Feb 1972).

The stationary luminescence of anodic ZrO_2 layers formed on zirconium in 0.5 N nitric acid, and induced to glow by uv light of wavelength $\lambda = 312.5$ nm is investigated. A curve of optical absorption of these layers was plotted, and the effect of temperature and uv light intensity on the total photoluminescence intensity was investigated. The thermal activation energy of the quenching process was determined to be $\epsilon = 0.08$ eV. Analysis was also made of intensities in the photoluminescence spectrum of the anodic layers, and a comparison then was made with the photoluminescence spectrum of spectrally pure ZrO_2. (auth)

22102 EFFECT OF HEAT TREATMENT AND IRRADIATION WITH GAMMA QUANTA FROM ^{60}Co ON THE PROPERTIES OF YTTRIUM-DOPED SILICON. Sinyukov, V. A.; Korostelev, Yu. A.; Morkovkin, E. I. (Inst. of Electronics, Tashkent). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 8, 1272-3(Aug 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 8, 1435-6(Aug 1971).

From studies on the effects of heat treatment and γ irradiation on Y-doped Si, it is suggested that Y, present as an impurity that influences the interaction of O with vacancies in Si, reduces the rate of injection of the level $E_c = 0.16$ eV. The area of the 9.1-μ absorption peak was reduced at the ends of crystals with Y as impurity, owing to its interaction with oxygen in the melt. (P.C.H.)

22103 DEFINING THE RANDOM SPECTRUM AS USED IN THE CHANNELING TECHNIQUE OF NUCLEAR BACKSCATTERING. Ziegler, J. F.; Crowder, B. L. (IBM Watson Research Center, Yorktown Heights, N. Y.). Appl. Phys. Lett.; 20: No. 4, 178-9(15 Feb 1972).

A new method is described for operationally defining a "random" spectrum as used in channeling studies of nuclear backscattering. The method is reproducible to 1%. A detailed analysis is made for the case of ^4He ions backscattered from silicon crystals. Corrections are determined so the "random" spectrum approximates that from an amorphous layer to within ±1%. (auth)

22104 INVESTIGATION OF RADIATION DAMAGE IN Re COMPOUNDS BY ANGULAR CORRELATIONS. Badica, T. (Inst. for Atomic Physics, Bucharest); Dima, S.; Gelberg, A.; (and others). pp 102-3 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Perturbed $\gamma-\gamma$ angular correlations in $^{188}Re \rightarrow {}^{188}Os$ decay were used to study the effects of chemical structure and radiation damage in K_2ReCl_6, $NaReO_4$, and NH_4ReO_4 irradiated by thermal neutrons. Strong dipolar and quadrupolar attenuations were observed which were modified by annealing. (D.L.C.)

22105 LOCATION OF IMPLANTED ATOMS VIA CHANNELING. Deutch, B. I. (Univ. of Aarhus, Denmark). pp 137-66 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The process of channeling of charged particles in a crystal lattice is considered in detail. Rutherford scattering and x-ray production are taken into account, and blocking of decay particles from inside the lattice is also considered. Examples of the location of implant sites are given using Yb-implanted Fe, doped semiconductors, etc. It is concluded that the lattice locations of implanted atoms depend on implantation and annealing conditions, and that substitutional, interstitial, and surface oxide sites must be considered when analyzing Moessbauer or PAC data. (23 references) (D.L.C.)

22106 LATTICE LOCATION OF Bi AND Tl IMPLANTED INTO IRON SINGLE CRYSTALS. Feldman, L. C.; Augustyniak, W. M.; Kaufmann, E. N. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 174-7 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The channeling technique was used to locate Bi and Tl implanted into Fe single crystals at 100 to 200 keV. An oxide layer was found on the surface, and 80 ± 10% of the implanted ions are on substitutional sites following the implantation, but only 25% after annealing at 800°C. Comparison with Bowman's internal hyperfine magnetic field at ^{207}Pb and ^{208}Pb in Fe indicates that the nonsubstitutional site is the high field site for Pb in Fe. (D.L.C.)

22107 INTERPRETATION OF CHANNELING EXPERIMENTS FOR IMPLANTED ATOM LOCATION IN CRYSTALS. Alexander, R. B. (Clarendon Lab., Oxford); Dearnaley, G.; Morgan, D. V.; Poate, J. M. pp 179-83 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publisher Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The computer simulation of He ion channeling in a Cu lattice shows that the flux distribution across the channel is not constant and is in fact considerably peaked in the center of the channel. The magnitude of the flux enhancement in the center of the ⟨100⟩ channels in Cu at 20°C was calculated for He ions of energies from 0.5 to 1.5 MeV. The effect of ignoring electronic dispersion was also determined. The flux enhancement falls rapidly with the angle of incidence, with a half width $\sim 1/4$ of the critical angle for channeling. The flux enhancement complicates the interpretation of atom location experiments, but if the foreign atoms occupy nonsubstitutional sites either near the center of the channel or near lattice sites, they can be located fairly accurately. (D.L.C.)

22108 LOCATION OF Au, Sb, AND Ce IMPLANTED INTO Fe SINGLE CRYSTALS. Alexander, R. B. (Clarendon Lab., Oxford); Stone, N. J.; Morgan, D. V.; Poate, J. M. pp 229-33 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The location of ^{197}Au, $^{121,123}Sb$, and ^{140}Ce implanted into Fe single crystals at 80 or 150 keV was studied, using the channeling and backscattering of 3.0-MeV ^{14}N ions. The results show that ~85% of Au and ~80% of Sb ions are on substitutional sites. For Au, the aligned yield along the ⟨110⟩ axis is higher than along the two other axes. A large fraction of the Ce ions probably occupies octahedral interstitial sites in the Fe lattice. (D.L.C.)

Physical Properties

Refer also to abstracts 20850, 20853, 20865, 20875, 20885, 20890, 20917, 20926, 21576, 21589, 21590, 21779, and 21783.

22109 (CONF-720304-1) SPIN-WAVES IN FERROMAGNETIC DYSPROSIUM METAL. Nicklow, R. M.; Wakabayashi, N. (Oak Ridge National Lab., Tenn.). Feb 1972. 11p. (SM-155/E-9). Dep. NTIS.

From fifth IAEA symposium on neutron inelastic scattering; Grenoble, France (6 Mar 1972).

The spin-wave dispersion relations for the [110] and [001] symmetry directions in ferromagnetic dysprosium metal (isotopically enriched 96.8% with ^{163}Dy) were studied between 4.7 and 77°K. Throughout this temperature range, the measured temperature dependence of the energy gap at zero wave vector ($\vec{q} = 0$) is in fair agreement with that predicted theoretically for the frozen-lattice model. However, the magnitude of the total planar anisotropy deduced from these gap measurements is larger by a factor of two than that obtained from macroscopic measurements. The increase of the magnon energies with decreasing temperature is much more pronounced at $\vec{q} = 0$ than near the Brillouin zone boundaries. Thus, the magnitude of the isotropic exchange interaction decreases substantially, about 25% in the [001] direction, between 77 and 4.7°K. Significant magnon–phonon interactions are observed, particularly in the [110] direction where the acoustic magnon branch is mixed with both the longitudinal and transverse acoustic-phonon branches. The peak in the Fourier transform of the exchange interaction, $J(\vec{q})$, which at 77°K occurs near the wave vector of the helical-magnetic structure of Dy just above T_c, persists down to 4.7°K with shifts to smaller $\vec{q}$ as the temperature is decreased. At 77°K the optic and acoustic spin-wave branches are degenerate, to within 0.1 meV, at the K-symmetry point of the Brillouin zone. However, at 4.7°K this degeneracy is lifted, with $\Delta E \simeq 0.8$ meV, thereby indicating the existence of a temperature-dependent long-range anisotropic magnetic interaction in Dy. (auth)

22110 (ITJ-9) NEUTRON DIFFRACTION AND MAGNETIC STUDIES OF ZnV_2O_4. Bombik, A.; Lesniewska, B.; Tucharz, A. (Institute of Nuclear Techniques, Krakow (Poland)). Mar 1971. 6p. Dep. NTIS (U. S. Sales Only).

Results of magnetic and neutron-diffraction measurements for normal spinel ZnV_2O_4 are presented. Obtained from the susceptibility curve were the paramagnetic Curie point $\theta = -256$°K, effective magnetic moment $\mu_{eff} = 2.18\ \mu_B$, and from neutron data, oxygen parameter $\mu = 0.3849$. (auth)

22111 (JAERI-M-4519) MAGNETIC AND ELECTRIC PROPERTIES OF URANIUM CARBONITRIDE AND OXYCARBIDE. Ohmichi, Toshihiko (Japan Atomic Energy Research Inst., Tokyo). Jul 1971. 75p. (In Japanese). NTIS (U. S. Sales Only).

Magnetic susceptibility, electrical resistivity, and thermoelectric power were measured for uranium carbonitride ($UC_{1-x}N_x$) and oxycarbide ($UC_{1-x}O_x$) to examine their electronic structures. $UC_{1-x}N_x$ are in two regions of composition, i.e., antiferromagnetic and paramagnetic, for which the magnetism and electron conduction characteristics are treated mainly in terms of the 7s–5f interaction. A qualitative electronic band scheme is proposed for the UC–UN system. It is pointed out that the behavior of $UC_{1-x}N_x$ compounds accompanied by the substitution of oxygen for carbon of UC, up to about 5 mole % UO, is distinguished from that of $UC_{1-x}N_x$ having the equivalent valence-electron concentration. (auth) (Japan)

22112 CONCERNING MAGNETIC BREAKDOWN IN BERYLLIUM. Alekseevskii, N. E.; Djir, P.; Nizhankovskii, V. I. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 4, 169-72(20 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 4, 256-60(20 Aug 1971).

The temperature dependence of the magnetoresistance–oscillation amplitudes was investigated in a wide temperature interval, using beryllium samples with $\rho(300°K)/\rho(4.2°K) \sim 150$. The measurements were performed in the field of a superconducting solenoid. (W.D.M.)

22113 MAGNETICALLY SOFT EUTECTIC COMPOSITES. Batt, J. A.; Thompson, E. R. (United Aircraft Research Labs., East Hartford, Conn.). J. Appl. Phys.; 43: No. 3, 1295-6(Mar 1972).

Unidirectional solidification of pseudoeutectic alloys from the (Fe, Co, Ni)–NbC system resulted in the formation of a (Fe, Co, Ni) solid-solution matrix reinforced by aligned NbC fibers. Room-temperature magnetic hysteresis loop and high-temperature saturation magnetization measurements were performed on controlled eutectic samples whose matrix compositions approximated those of well-known magnetic alloys. The most significant of these materials appears to be the (Fe, 50 wt % Co)–NbC eutectic which should combine useful high-temperature strength in the direction of the fibrous carbide with superior soft magnetic properties. (auth)

22114 THERMOELECTRIC PROPERTIES OF THE URANIUM OXIDE U_3O_8. Djerassi, H.; Sorriaux, A. P. (Centre d'Etudes Nucleares de Saclay, Gif-sur-Yvette, France). J. Appl. Phys.; 43: No. 3, 1275-6(Mar 1972).

Thermoelectric power and electrical conductivity results between 300 and 1450°K show that U_3O_8 (sintered) exhibits an intrinsic semiconducting behavior at high temperature. The energy gap is estimated to be about 0.48 eV. (auth)

22115 DOMAIN WALL PINNING AS A SOURCE OF MAGNETIC HARDENING IN ALLOYS. Gaunt, P. (Univ. of Manitoba, Winnipeg, Can.). J. Appl. Phys.; 43: No. 2, 637-8(Feb 1972).

A simple formal model of domain wall pinning by inhomogeneities in ferromagnetic alloys is developed. Particular attention is paid to the variation of coercivity with temperature, and it is shown that the coercive field varies linearly with the temperature of observation for an idealized form of magnetic inhomogeneity. This linear variation is observed in PtCo and $SmCo_5$ alloys, and it is estimated that each inhomogeneity changes the wall energy by about 2×10^{-12} erg. The diameter of the inhomogeneities in $SmCo_5$ is estimated to be about 34 Å. (auth)

22116 STUDY OF THE MOESSBAUER EFFECT, MAGNETIZATION, AND CRYSTAL STRUCTURES OF THE PSEUDOBINARY COMPOUNDS $TbCo_{5-5x}Fe_{5x}$ AND $ThNi_{5-5x}Fe_{5x}$. van Diepen, A. M.; Buschow, K. H. J.; van Wieringen, J. S. (Philips Research Labs., Eindhoven, Netherlands). J. Appl. Phys.; 43: No. 2, 645-50(Feb 1972).

The compounds $TbCo_{5-5x}Fe_{5x}$ and $ThNi_{5-5x}Fe_{5x}$ form two series of complete solid solutions. All compounds investigated show the hexagonal $CaCu_5$ structure. The lattice constants, the Curie temperatures, and the saturation moments at 4.2°K were determined as a function of x. The ThM_5 compounds possess two nonequivalent crystallographic sites for the M atoms (M = Fe, Co, Ni). By means of the Moessbauer effect, it is shown that the physical nature of atoms occupying these sites differs appreciably. It is also shown that replacement of Co or Ni by Fe in $ThCo_5$ or $ThNi_5$ proceeds with a strong preference for one of these two sites. The crystalline anisotropy of the compounds $TbCo_{5-5x}Fe_{5x}$ was studied as a function of x. It could be shown that the anisotropy in $TbCo_5$ is not particularly due to one of the two Co sites. With decreasing values for x, starting from $ThFe_5$, the Fe moment increases down to x = 0.6. This is explained in terms of a rigid-band model. (auth)

22117 FIELD-ENHANCED PHOTO-EMISSION FROM TUNGSTEN. Neumann, H.; Kleint, Ch. (Univ., Leipzig). Ann. Phys. (Leipzig); 27: No. 3, 237-47(1971). (In German).

Experimental results on the behavior of the field emission current from W with simultaneous illumination of the emitter are reported. The measurement method is described in detail. The research results can be explained only when the band structure of the emitter material is considered. The data obtained from the photocurrent field intensity characteristic lines for various spectral composition of the radiation emitted agree qualitatively with the theoretically calculated band structure for W. (tr-auth)

22118 INVESTIGATION OF THE ELECTRONIC STRUCTURE OF α'-CERIUM BY ANGULAR-CORRELATION STUDIES OF POSITRON-ANNIHILATION RADIATION. Gempel, R. F.; Gustafson, D. R.; Willenberg, J. D. (Wayne State Univ., Detroit). Phys. Rev.; B; 5: No. 6, 2082-5(15 Mar 1972).

The electronic structures of the γ, α, and α' phases of cerium metal were investigated by measurement of the angular correlation of positron-annihilation radiation at pressures up to 90 kbar. The observed increase in the width of the angular correlation with increasing pressure was small and consistent with the assumption that the number of free electrons per atom is essentially the same, presumably three, in all three phases. The changes in width were much smaller than predicted by the promotional model which assumes that the 4f electron is promoted to the conduction band as cerium is compressed. It is therefore concluded that the promotional model does not provide a satisfactory explanation of the high-pressure behavior of cerium metal. (auth)

22119 X-RAY DIFFRACTION OF ELEVATED-TEMPERATURE Th–C–N ALLOYS. Benz, R.; Balog, G. (Los Alamos Scientific Lab., N. Mex.). High Temp. Sci.; 3: No. 6, 511-22(Nov 1971).

Unit-cell dimensions of various Th–C–N phases were measured at temperatures up to 2250°C with an x-ray diffractometer. Unit-cell dimensions of the fcc phases of ThC–ThN and ThC–ThC_2 alloys at 1800°C vary linearly with ThC mole fractions in accord with the Vegard's rule. Positive deviations from the Vegard's rule occur in Th–ThC alloys. 29 references. (auth)

22120 ELASTIC CONSTANTS OF DILUTE Mo–Re ALLOYS. Kesharwani, K. M.; Agrawal, Bal K. (Univ. of Allahabad, India). Phys. Rev., B; 5: No. 6, 2130-5(15 Mar 1972).

The T-matrix method was used for determining the effects of a low concentration of randomly distributed point defects on the elastic constants of a crystal of bcc structure. The expressions for the bulk elastic constants were obtained in terms of the local changes in the central and noncentral force constants. The lattice dynamics of molybdenum are discussed in Kreb's model with interactions up to second neighbors. The obtained eigenfrequencies and the eigenvectors are used to evaluate the different Green's-function matrix elements. Numerical estimates are made for molybdenum crystals containing two different concentrations (7 and 7.4%) of rhenium. The results are compared with the experimentally measured elastic constants of the dilute alloys. An almost exact agreement between the theory and the experiment is observed. (auth)

22121 ANOMALOUS PROPERTIES OF THE VANADIUM OXIDES. Goodenough, John B. (Massachusetts Inst. of Tech., Lexington). Annu. Rev. Mater. Sci.; 1: 101-38(1971).

Vanadium oxides have outer 3d electrons that may be either localized or itinerant, depending upon the strengths of the cation-cation or cation-anion-cation interactions. Properties of the AVO_3 perovskites show that V^{m+}–O^{2-}–V^{m+} π-bond interactions are strong enough to delocalize the 3d electrons if $m \geq 4$, but not if $m \leq 3$. A critical V–V separation $R_c \approx 2.93 \pm 0.04$ Å, originally deduced from the properties of several isostructural series of compounds, was confirmed for an integral number of 3d electrons per cation by studies of VO_x, V_2O_3, and VO_2. The high-temperature transition in V_2O_3 was found to involve a band crossing as well as changes in the correlations among itinerant 3d electrons; the low-temperature transition was found to involve a disproportionation of narrow-band electrons into localized and itinerant electrons. The two components of the semiconductor-to-metal transition in VO_2 were: the formation of bonded ($R < R_c$) V–V pairs separated by $R > R_c$ and ferroelectric-type displacements that create double d-orbital V–O bonds. The role of native defects in VO_x and the "alloy problem" in mixed systems are briefly discussed. The Seebeck coefficient was used to characterize the sites available to small polarons in $M_x^{+}V_2O_5$-β phases and several vanadium spinels. A critical V_P–V separation for small-polaron formation appeared to be $R_c \approx 2.97$ Å. (68 references). (auth)

22122 CRYSTAL GROWTH. Laudise, R. A.; Carruthers, J. R.; Jackson, K. A. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Annu. Rev. Mater. Sci.; 1: 253-88(1971).

A review is presented of the early-1971 status of crystal growth theory and practice and future trends. The theory includes both microscopic and macroscopic theory, and crystal growth as an exploratory materials research tool and growth techniques are dis-

cussed. Characterization of the crystals is discussed. 180 references. (D.L.C.)

22123 LATTICE DYNAMICS OF TRANSITION METALS. Bajpai, R. P.; Neelakandan, K. (Indian Inst. of Tech., New Delhi). Nuovo Cim.; 7B: No. 2, 177-84(11 Feb 1972).

Frequency/wave-vector dispersion relations for the normal models of vibration of four bcc transition metals, viz. α-Fe, Nb, Ta, and W, were calculated from the modified axially symmetric model, which takes into account the effect of conduction electrons. Calculated phonon frequencies agree fairly well with the experimental neutron-scattering data. (auth)

22124 MAGNETIC AND STRUCTURAL PROPERTIES OF THE NEODYMIUM–DYSPROSIUM ALLOY SYSTEM. Chatterjee, D.; Taylor, K. N. R. (Univ. of Durham, Eng.). J. Phys., F (London); 2: No. 1, 151-8(Jan 1972).

The magnetic and structural properties of the neodymium–dysprosium alloy system were measured over the entire composition range. The crystal structures changed from hcp to Sm-type to dhcp arrangement with increasing neodymium concentration. Magnetization and initial susceptibility measurements suggest that the dhcp phase does not order magnetically. In the Sm phase antiferromagnetic behavior was observed, while the hcp alloys showed a step-ordering process. The Néel points followed a $^2/_3$-power-law variation with a reduced de Gennes function $\bar{G}$ given by the difference of the de Gennes functions for the two components of the alloy. (auth)

22125 TEMPERATURE COEFFICIENT OF RESISTANCE OF BULK Ta_2N. Hieber, K.; Meyer, A. (Siemens AG, Munich). J. Less-Common Metals; 26: No. 2, 313-17(Feb 1972).

The temperature coefficient of resistance (TCR), α, and resistivity, ρ, of bulk Ta_2N were determined in order to separate thin-film effects. In all cases a constant, positive TCR, α = (+180 ± 30) ppM/deg was observed for temperatures between approximately 20 and 400°C. The room-temperature resistivity was (175 ± 10) $\mu\Omega$ cm. However, the results for bulk Ta_2N were not in agreement with those reported for sputtered films of Ta_2N. The positive TCR of bulk Ta_2N is in contradiction to the negative values reported for thin films. On the basis of Matthiessen's rule the results can be understood, since it is to be expected that the scattering of electrons by defects in pure Ta_2N lowers the TCR, but only to a small positive value. The results indicate, therefore, that the occurrence of a negative TCR in thin Ta_2N films having a thickness greater than 1000 Å must be due to another conduction mechanism. (P.C.H.)

22126 MAGNETIC PROPERTIES OF RARE EARTH–Pd_3 PHASES. Gardner, W. E. (Atomic Energy Research Establishment, Harwell, Eng.); Penfold, J.; Smith, T. F.; Harris, I. R. J. Phys., F (London); 2: No. 1, 133-50(Jan 1972).

Magnetic measurements for 1.5 to 300°K on the complete series of Cu_3Au-type RPd_3 phases were made. $LaPd_3$ and $LuPd_3$ are diamagnetic at room temperature. $CePd_3$ shows Pauli-type paramagnetism indicative of a nonmagnetic virtual bound state. $PrPd_3$ and $NdPd_3$ are affected at low temperatures by the presence of the crystal field. The magnetic properties of $SmPd_3$ and $EuPd_3$ are determined by the energy levels of the lowest multiplet. $GdPd_3$ and (possibly) $TbPd_3$ become antiferromagnetic at 7.5 and 2.5°K, respectively. $DyPd_3$ and $ErPd_3$ obey the Curie law. The magnetic properties of these phases are discussed in relation to crystal field effects and a possible band structure. (auth)

22127 MEASURING THE ELECTRICAL RESISTANCE OF OXIDE CERAMICS AT HIGH TEMPERATURES. Shakhtin, D. M.; Pivovar, T. L. (Ukrainian Scientific-Research Inst. of Refractories, Kharkov). Refractories (USSR) (Engl. Transl.); 12: No. 7-8, 537-40(Jul-Aug 1971).

Translated from Ogneupory; 12: No. 8, 59-62(Aug 1971).

The electric resistances of CaO-stabilized ZrO_2, MgO, and aluminomagnesia spinel ($MgAl_2O_4$) were measured in the temperature range 800 to 2300°C by the double-probe method. The contact and volume components of the resistance were determined. The ionic conductivity was measured with alternating current of frequencies 500 to 20,000 cps. (D.L.C.)

22128 EFFECT OF MAGNETIC FIELD ON THE CRYSTAL STRUCTURE OF GADOLINIUM. Finkel, V. A.; Belovol, V. S. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 61: No. 6, 2347-53(Dec 1971). (In Russian).

Results on a study of the crystal structure of gadolinium at 150 to 373°K in magnetic fields at field strengths up to 16 kOe are presented. It is shown that magnetic deformation of the crystal structure is maximal at the Curie point. The variation of the a and c parameters of the hcp lattice is of opposite sign throughout the whole temperature range. Results of determination of the magnetostriction parameters for gadolinium are presented. It is noted that anisotropy in the ac plane plays an important role in magnetic deformation of the gadolinium crystal lattice. (auth)

22129 ELECTRICAL RESISTIVITY AND THERMOELECTRIC POWER OF $UC_{1-x}N_x$. Ohmichi, Toshihiko; Kikuchi, Takeo; Nasu, Shoichi (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 2, 77-85(Feb 1972).

Measurements were carried out on the electrical resistivity ρ (4 to 1100°K) and the absolute Seebeck coefficient (77 to 800°K) of uranium carbonitride $UC_{1-x}N_x$ ($0 \leq x \leq 1$), which has a NaCl structure. The electrical resistivity of various compositions from UN to $UC_{0.4}N_{0.6}$ exhibits changes, near the Néel temperature, in the slope of the lines relating the resistivity to temperature. From the resistivity–temperature relation, the temperature derivative $d\rho/dT$ was determined in particular detail in the vicinity of the critical region, and the Néel temperature was derived therefrom, for compositions from UN to $UC_{0.4}N_{0.6}$. A qualitative band picture is proposed based on the results of the composition dependence of the temperature derivative of the Seebeck coefficient dS/dT. The composition dependence of the electrical resistivity of $UC_{1-x}N_x$ is discussed with reference to the density of state obtained from specific heat measurements reported in the literature. The resistivity of the spin disorder term ρ_m for compositions from UN to $UC_{0.4}N_{0.6}$ changes apparently in the relation $\rho_m \propto x^5$, and this is discussed in reference to the RKKY theory. (auth)

22130 ESTIMATION OF ELECTRICAL RESISTIVITY INCREASE DUE TO CARBON DEFICIENCY IN URANIUM MONOCARBIDES. Sakanishi, Ken-ichi; Matsui, Hisayuki (Nagoya Univ., Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 2, 124-5 (Feb 1972).

Electric resistivity was measured for as-cast and annealed UC_{1-x} from 77 to 300°K. The resistivity of as-cast UC increased linearly with x up to x = 0.033, reaching saturation at higher values of x. For annealed UC, the resistivity increased only up to x = 0.012, after which it decreased. The resistivity of stoichiometric UC is estimated to be 35 ± 1 and 12 ± 1 $\mu\Omega$ cm for the as-cast material at 300 and 77°K, and 32 ± 3 and 10 ± 2 $\mu\Omega$ cm for the annealed material at 300 and 77°K. (D.L.C.)

22131 PROPERTIES OF ZIRCONIUM MONOCARBIDE IN ITS REGION OF HOMOGENEITY. Samsonov, G. V.; Upadkhaya, G. Sh. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 8, 1203-5(Aug 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 8, 1351-4(Aug 1971).

Studies were made on the electrical resistivity, Hall coefficient, thermo-emf, room-temperature magnetic susceptibility, and temperature dependences of the resistivity and thermo-emf of zirconium monocarbide in its region of homogeneity at 500 to 1000°C. The results are discussed in relation to the electron structure of the carbide phases. (auth)

22132 EFFECT OF HEAT TREATMENT ON THE ELECTRICAL CONDUCTIVITIES OF MATERIALS OF THE SYSTEM CdO–Bi_2O_3. Valeev, Kh. S.; Baklanov, E. G. Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 8, 1302-3(Aug 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 8, 1463-4(Aug 1971).

Specimens of CdO–Bi_2O_3 were heated to 470 to 600°C (according to composition) and then cooled rapidly. After quenching the electric conductivities were measured. For compositions with 48% CdO, the conductivity after threefold thermal treatment decreased by more than 10 orders of magnitude (subsequent thermal shock did not alter δ). Quenched specimens kept for one month at room temperature did not show changes in their acquired conductivity values. Restoration of the original values was easily obtained by annealing at 600°C followed by slow cooling. Specimens with 30% CdO or less, after quenching at 520°C, not only had reduced conductivities, but also changed color from dark gray to greenish. The conclusion of freezing of defects of Cd(Bi) is also favored by the fact that, for quenched specimens, the temperature dependence of the conductivity has none of the anomalies characteristic of the ordinary specimens. (P.C.H.)

22133 RESONANT ELECTRONIC POLARIZATION IN THE LATTICE DYNAMICS OF TRANSITION-METAL COMPOUNDS. Weber, W. (Univ., Munich); Bilz, H.; Schroeder, U. Phys. Rev. Lett.; 28: No. 10, 600-3(6 Mar 1972).

Recently observed anomalies in the phonon spectra of HfC, TaC, and NbC are interpreted as resonances in the electronic polarization. These effects are described by a specific extension of the shell model. The possible connections of these anomalies to lattice instabilities and superconductivity are discussed. (auth)

22134 HYPERFINE INTERACTIONS IN EXCITED NUCLEI. VOLUME 1. Conference Held at Rehovot and Jerusalem, Israel, September 6–11, 1970. Goldring, Gvirol; Kalish, Rafael (eds.). New York; Gordon and Breach Science Publishers Inc. (1971). 384p. (CONF-700933-(Vol.1)).

Thirty-six papers are included on the following topics: ion implantation, hyperfine fields and interactions, nuclear orientation, lattice location of implanted atoms, nuclear properties. Separate abstracts were prepared for 13 of the papers. Two of the remaining papers were previously abstracted in NSA (see NSA 25: 7441 and 17273). (D.L.C.)

For abstracts of individual papers see: 21690, 21818, 21842, 22104–22108, 22135, 22136, and 22153–22155.

22135 IMPLANTATION INTO FERROMAGNETIC MATERIALS AND THE MAGNETIC SATURATION. Aharoni, Amikam (Weizman Inst. of Science, Rehovot, Israel). pp 75-82 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Ions implanted into ferromagnetic foils in order to exploit the large effective magnetic fields are useful only if the magnetization is aligned, especially in the vicinity of the implanted ion. Calculations for magnetostriction effects on W impurity in Ni are presented of the angle between the applied field and the field at the impurity site as a function of the angle between a Ni cubic axis and the applied field, and of the angle between the applied field and the internal field at a distance r from the W nucleus. Implantation into Permalloy with ~80% Ni, whose magnetostriction is small, is suggested. (D.L.C.)

22136 DETERMINATION OF THE INTERNAL MAGNETIC FIELD IN PURE VANADIUM WITH NUCLEAR ORIENTATION AND POLARIZED NEUTRONS. Postma, H.; Vanneste, L.; Sailor, V. L. (Brookhaven National Lab., Upton, N. Y.). pp 358-60 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A very pure V sample was polarized in a magnetic field up to 50 kOe, and a beam of polarized neutrons of 0.115 eV was directed through this target. The transmission ϵ (relative transmission for parallel and antiparallel cases) was measured for both V and In. The results indicate that the internal field in V is less than 4 kOe down to 0.06°K. There was no ferromagnetism in the V sample. (D.L.C.)

22137 HYPERFINE INTERACTIONS IN EXCITED NUCLEI. VOLUME 2. Conference Held at Rehovot and Jerusalem, Israel, September 6–11, 1970. Goldring, Gvirol; Kalish, Rafael (eds.). New York; Gordon and Breach Science Publishers Inc. (1971). 395p. (CONF-700933-(Vol.2)).

Thirty-six papers are presented on hyperfine interaction and nuclear orientation, and isomer shift and mesic atoms. Separate abstracts were prepared for sixteen of the papers. For abstracts of two of the remaining papers, see NSA 25: 8145 and 8146. (D.L.C.)

For abstracts of individual papers see: 21301–21303, 21711, 21778, 21819–21821, 22138–22142, and 22156–22158.

22138 INFLUENCE OF DEFECTS AND OF IMPURITIES ON THE EFG PARAMETERS IN METALLIC HAFNIUM. Berthier, J.; Boyer, P.; Vargas, J. I. (CEN, Grenoble, France. pp 439-47 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Results are given of differential-perturbed angular correlation measurements on Hf samples of different impurity contents. The electric-field-gradient parameters are tabulated. (D.L.C.)

22139 HYPERFINE INTERACTIONS IN HAFNIUM SINGLE CRYSTALS OBSERVED BY TIME DIFFERENTIAL ANGULAR CORRELATION MEASUREMENTS. Lieder, R. M.; Buttler, N.; Killig, K; Beck, K.; Bodenstedt, E. (Univ., Bonn). pp 449-55 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Perturbed angular correlations were used to study magnetic and electric hyperfine interactions in the 482-keV level of ^{181}Ta embedded in Hf single crystals. The electric quadrupole interaction was measured between 4.2 and 560°K. The lattice contribution to the electric field gradient was calculated and found to agree with experiment. The combined collinear electric and magnetic hyperfine interaction was also measured. (D.L.C.)

22140 NEW METHOD FOR DIFFERENTIAL PERTURBED ANGULAR CORRELATION MEASUREMENTS. Raghavan, R. S.; Raghavan, P.; Sperr, P. (Technische Hochschule, Munich). pp 462-3 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

In the usual differential PAC method, the external field is perpendicular to the detector plane and the Larmor modulation is $2\omega_L$. This method fails when the field is large. A new method is reported in which the modulation frequency is just ω_L and the magnetic field is applied in the plane of the detectors, at 45° to the fixed detector, while the second detector is placed successively at 90 and 180° to the first. Thus, twice as large a hyperfine field can be measured. This method is demonstrated for ^{111}Cd in Fe (hyperfine field = 366 ± 7 kG). (D.L.C.)

22141 TEMPERATURE DEPENDENCE OF ELECTRIC-QUADRUPOLE HYPERFINE INTERACTIONS AT YTTERBIUM IMPURITIES IN THULIUM METAL. Chuhran, A. R.; Li-Scholz, A.; Rasera, R. L. (Univ. of Pennsylvania, Philadelphia). pp 464-5 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Electric-quadrupole interactions at ytterbium nuclei in a thulium metal host was measured from 77 to 468°K using time-differential perturbed angular correlations in the decay of ^{172}Lu. The temperature dependence of the quadrupole interaction strength is approximately linear over the entire temperature range, from $(249 \pm 4) \times 10^6$ rad/sec at 77°K to $(155 \pm 10) \times 10^6$ rad/sec at 468°K, indicating that the ytterbium impurities are doubly ionized. The temperature dependence of the electric field gradient (EFG) is therefore that of the sum of lattice and conduction-electron contributions only. The temperature variations of both the lattice and the conduction-electron EFG's are both approximately linear. (D.L.C.)

22142 HYPERFINE FIELD FOR Pd, Cd, AND Te IN GADOLINIUM. Bostroem, L.; Johansson, K.; Karlsson, E.; Norlin, L.-O. (Univ. of Uppsala). pp 466-7 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The Pd hyperfine field in Gd at 77°K was determined from IPAC of ^{106}Ru–^{106}Pd to be −64 ± 6 kG. The temperature dependence of the Cd hyperfine field in Gd was found to deviate slightly from the reduced magnetization curve for Gd; the electric frequency at 295°K is $(23.7 \pm 0.5) \times 10^6$ rad/sec and the field at 77°K is −312 ± 9 kG. For Te in Gd, the electric frequency at 300°K is $(270 \pm 70) \times 10^6$ rad/sec, and the hyperfine field at 77°K is −38 ± 10 kG. (D.L.C.)

22143 HYPERFINE INTERACTIONS IN EXCITED NUCLEI. VOLUME 3. Conference Held at Rehovot and Jerusalem, Israel, September 6–11, 1970. Goldring, Gvirol; Kalish, Rafael (eds.). New York; Gordon and Breach Science Publishers Inc. (1971). 275p. (CONF-700933-(Vol.3)).

Thirty-four papers are presented on Moessbauer effect in transition elements and hyperfine interactions in stripped atoms. Separate abstracts were prepared for 18 of the papers. (D.L.C.)

For abstracts of individual papers see: 21339, 21691, 21712, 21779–21782, 21822–21824, 22144–22146, and 22159–22163.

22144 MAGNETIC HYPERFINE FIELDS ON HOLMIUM AND LUTETIUM IN Ho–Lu ALLOYS. Schott, W. (Kernforschungszentrum, Karlsruhe. Brookhaven National Lab., Upton, N. Y.). pp 787-93 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

From transmission measurements of polarized neutrons with polarized targets, the hyperfine fields in three Ho–Lu alloys were determined. The alloys contained 19, 40, and 81 at.% holmium. On holmium, the measured fields were +5041 ± 187, +6128 ± 227, and +6824 ± 183 kOe; on lutetium, +22 ± 4, +128 ± 25, and +787 ± 129 kOe, respectively. (auth)

22145 CRYSTAL-FIELD EFFECTS FOR Er^{3+} IN $HoAl_2$ STUDIED BY PAC. Waeppling, R.; Karlsson, E.; Carlsson, G.; Bajaj, M. M. (Inst. of Physics, Uppsala). pp 836-8 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The effect of the crystal field on the hyperfine field of Er^{3+} in $HoAl_2$ was studied in the paramagnetic state. The paramagnetic amplification factor β of the electronic shells was calculated for different values of the crystal-field strength. The cubic crystal field was found to be weak (<10K). (D.L.C.)

22146 HYPERFINE INTERACTIONS IN TRANS-LEAD ELEMENTS VIA $\alpha-\gamma$ PAC. Ansaldo, E. J.; Grodzins, L. (Massachusetts Inst. of Tech., Cambridge). pp 921-9 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A systematic study of the hyperfine interactions acting on trans-lead elements after alpha decay-recoil implantation is being pursued in a variety of environments. The interactions in copper are of quadrupolar nature, time-fluctuating for the actinides, while the interactions in vacuum are magnetic. The effective magnetic field in ferromagnetic metals has been measured in a few cases (Rn, Ra, Th, and Np in Fe and Ni). (auth)

22147 RECOIL INTO NONMAGNETIC METALS. Herskind, B. (Univ. of Copenhagen). pp 987-1032 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A review is presented of ion-implantation perturbed angular correlation (IMPAC) as a technique for the study of hyperfine interactions. The interactions observed when heavier nuclei (A > 150) are implanted into nonmagnetic material (Cu) are discussed, and the application of IMPAC to quadrupole interactions in single crystals is considered, with some experimental results given for ^{176,180}Hf in Hf single crystals. (42 references) (D.L.C.)

22148 IMPLANTATION PERTURBED ANGULAR CORRELATION STUDIES OF $^{182\ 184\ 186}$W IN GADOLINIUM SINGLE CRYSTALS. Kaufmann, E. N. (Bell Telephone Labs., Murray Hill, N. J.); Murnick, D. E.; Alonso, C. T.; Grodzins, L. pp 1033-6 of Hyperfine Interactions in Excited Nuclei. Vol. 4. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A 42-MeV beam of ^{16}O ions was used to implant recoil tungsten nuclei into a thin gadolinium single crystal at room temperature. The $2^+ \rightarrow 0^+$ gamma-ray angular distribution in coincidence with backscattered ions exhibited pure electric quadrupole perturbations, with the z axis collinear with the c axis of the gadolinium crystal. The interaction parameters were determined to be $\omega_0\tau = 0.30 \pm 0.04$, 0.25 ± 0.04, and 0.26 ± 0.04 for ^{182}W, ^{184}W, and ^{186}W, respectively. $|V_{zz}|$ for W in Gd was found to be $(5.24 \pm 1.00) \times 10^{17}$ V/cm^2 if quadrupole moments derived from B(E2) values are assumed. (D.L.C.)

Moessbauer Effects and NMR

Refer also to abstracts 21690, 21778, 21810, 21811, 21819, 21821, 21935, 21936, and 22143.

22149 ^{11}B NMR IN CRYSTALLINE BORON OXIDE. Rhee, C.; Bray, P. J. (Brown Univ., Providence). J. Chem. Phys.; 56: No. 5, 2476-8(1 Mar 1972).

NMR studies were made in an effort to decide between the B_2O_3 structures proposed by Strong and Kaplow (Acta Cryst., B24: 1032(1968)) and Gurr et al. (Acta Cryst. B26: 906(1970)). Three spectrometer frequencies (16, 10, and 6 MHz) and polycrystalline samples were used. Computer simulation of the experimental traces was attempted using one boron site and two distinct boron sites; e^2qQ/h, η, and 2σ were adjusted. The results show that present powder NMR techniques are unable to distinguish between the two BO_3 triangles proposed by Gurr et al. (D.L.C.)

22150 ^{13}C NMR SPECTROSCOPY: A BRIEF REVIEW. Stothers, J. B. (Univ. of Western Ontario, London). Appl. Spectrosc.; 26: No. 1, 1-16(Jan-Feb 1972).

An introduction to the chemical applications of ^{13}C NMR spectroscopy is presented. The features of the basic instrumentation are outlined, and a brief survey of ^{13}C shieldings in hydrocarbons is given to show the general trends and to indicate the major contributing factors. Some recent applications are described to illustrate the potential of ^{13}C techniques for solving chemical problems. 64 references. (auth)

22151 OBSERVATION OF INTERFERENCE EFFECTS IN THE MOESSBAUER ABSORPTION SPECTRA OF E2 AND E2/M1 TRANSITIONS. Wagner, F. E. (Argonne National Lab., Ill.); Dunlap, B. D.; Kalvius, G. M.; (and others). Phys. Rev. Lett.; 28: No. 9, 530-3(28 Feb 1972).

In a transmission geometry, dispersion terms were observed in the shapes of the Moessbauer resonance lines of pure E2 and mixed E2/M1 transitions. For the pure E2 transitions studied, the relative magnitude of these terms, which are attributable to interference effects, is typically 1.5% of the depth of the absorption line. Possible consequences of the resulting asymmetric line shape for isomer-shift measurements are discussed. (auth)

22152 MOESSBAUER TIME-REVERSAL STUDIES. Chrisman, Bruce Lowell. Urbana; Univ. of Illinois (1971). 66p. University Microfilms Order No. 72-6893.

Thesis.

Moessbauer time-reversal experiments were investigated in an attempt to lower the upper limit on the time-reversal-violating part of the mixed electromagnetic–hadronic Hamiltonian. The search was unsuccessful. However, in the process of analytically describing the experiments, an S-matrix formalism was developed that is applicable to most forms of Moessbauer experiments. (Diss. Abstr. Int., B)

22153 QUADRUPOLE EFFECTS IN NMR SPECTRA ON SHORT-LIVED β-RADIOACTIVE NUCLEI, ^{12}B AND ^{12}N. Sugimoto, K.; Mizobuchi, A.; Matuda, K.; Minamisono, T. (Osaka Univ.). pp 167-73 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Polarized ^{12}B and ^{12}N were produced in bcc metals (Nb, Mo, Ta, W) by ^{11}B(d,p) and ^{10}B(^{3}He,n) reactions. A frequency-modulated rf field was used, and quadrupole coupling constants in the bcc metals were derived. The line widths of ^{12}B and ^{12}N in fcc metals (Al, Cu, Pt, Au) were also reinvestigated. The results indicate that the implanted sites are interstitial. The coupling constants of ^{12}B in ZrB_2 and TiB_2 were determined, and the quadrupole moment of ^{12}B was deduced to be $|Q(^{12}B)| = 0.0171 \pm 0.0016$b. (D.L.C.)

22154 REVIEW OF RECENT DEVELOPMENTS IN LOW-TEMPERATURE NUCLEAR ORIENTATION. Stone, N. J. (Clarendon Lab., Oxford). pp 237-90 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

A survey is presented of ion implantation for preparation of sources for nuclear orientation (NO), nuclear magnetic resonance of oriented nuclei (NMR/ON) in ferromagnetics, the use of NO to study nuclear spin–lattice relaxation times in ferromagnetic metals at very low temperatures, and NO studies of dilute magnetic impurity alloy systems (Kondo states, etc.). (68 references) (D.L.C.)

22155 SPIN ROTATION, STROBOSCOPY, AND DYNAMIC PERTURBATIONS. Recknagel, E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin. Freie Univ., Berlin). pp 291-312 of Hyperfine Interactions in Excited Nuclei. Vol. 1. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The determination of nuclear moments of isomeric states populated by nuclear reactions is discussed. The experimental methods, especially the spin rotation method (DPAD) and the stroboscopic observation of nuclear Larmor precession (SOPAD), are described. The survey of the results concentrates on isomeric states with mean lives $\tau > 1$ μsec and on the implications that follow from the nuclear reaction process. A temperature-dependent relaxation mechanism associated with the radiation damage in solids is discussed in detail, in the case of As nuclei in germanium. A comparison between experimental values of magnetic moments with theoretical predictions is given in an example. (22 references) (auth)

22156 EVALUATION OF ISOMER SHIFTS. Kalvius, G. Michael (Argonne National Lab., Ill.). pp 523-94 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The evaluation of isomer shifts as obtained from Moessbauer experiments is reviewed. After a brief introduction to the theory of the isomer shift, different methods of calculating the change in electron charge density at the nucleus $\Delta|\psi_0|^2$ are discussed in some detail. In particular, the application of free-atom self-consistent field calculations is evaluated. The experimental values of the changes in mean square nuclear charge radius with excitation, $\Delta\langle r^2\rangle$, as obtained from Moessbauer and muonic isomer shifts, are compared with the available theoretical predictions, and discussed briefly in terms of various nuclear models. (100 references) (auth)

22157 HYPERFINE ANOMALIES. Perlow, G. J. (Argonne National Lab., Ill.). pp 651-79 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Work on the hyperfine anomaly in ^{193}Ir and ^{191}Ir, as measured by the Moessbauer effect, is described. Measured anomalies of ^{191}Ir and ^{193}Ir are compared with these for gold isotopes. Moessbauer spectra are given for Ir metal and IrF_6. The value of the ^{193}Ir anomaly is discussed from the standpoint of nuclear models. (19 references) (D.L.C.)

22158 ELECTRON DENSITIES AND ISOMER SHIFTS FOR VARIOUS NEPTUNIUM IONS. Dunlap, B. D. (Argonne National Lab., Ill.); Shenoy, G. K.; Kalvius, G. M.; Cohen, D.; Mann, J. B. pp 709-17 of Hyperfine Interactions in Excited Nuclei. Vol. 2. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Results are presented of free-ion self-consistent-field calculations of the electron density at the nucleus $|\psi_0|^2$. Nonrelativistic and relativistic numbers ($\Delta|\psi_0|^2$) are compared. Shell-by-shell contributions to $|\psi_0|^2$ are given for the configurations $5f^1$ and $5f^2$. Isomer shifts are given for a number of Np compounds. The change in nuclear charge radius is found to be $-27 \pm 5 \times 10^{-3}$ fm^2 for ^{237}Np. (D.L.C.)

22159 HYPERFINE STRUCTURE IN f-SHELL ELEMENTS. Nowik, I. (Hebrew Univ., Jerusalem). pp 769-86 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Some of the recent studies of hyperfine interactions in the rare-earth and actinide regions performed by the Jerusalem group, using the Moessbauer-effect technique, are reviewed. (14 references) (auth)

22160 MAGNETIC FIELD AND CHARGE DENSITY OF CONDUCTION ELECTRONS AT NUCLEI IN RARE EARTH METALS. Henning, W.; Baehre, G.; Kienle, P. (Technische Univ., Munich). pp 795-801 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Moessbauer isomer shifts and magnetic splitting of rare earth nuclei embedded in 4f metals were measured. The conduction-electron density at the nucleus relative to the electron density difference between the trivalent and divalent ions, and the electron density at the ion in neighboring metals relative to its own metal are listed for Eu in Gd and Sm, Gd in Sm, Dy in Gd, and Yb in Tm and Lu. The magnetic splitting of the Moessbauer spectra reported is for ^{153}Eu in Gd and Sm. (D.L.C.)

22161 ISOMER SHIFTS AND HYPERFINE SPLITTING OF THE 145-keV MOESSBAUER LINE OF ^{141}Pr. Kapfhammer, W.; Maurer, W.; Wagner, F. E.; Kienle, P. (Technische Univ., Munich). pp 839-45 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

The Moessbauer scattering of the 145-keV γ rays of ^{141}Pr was observed in a number of Pr compounds and in Pr metal. Large isomer shifts were found between Pr(III) and Pr(IV). From the hyperfine pattern of PrO_2, the magnetic moment of the 145-keV state $\mu_{\frac{5}{2}} = (2.8 \pm 0.2)\mu_N$ was derived. (auth)

22162 STUDY OF HYPERFINE INTERACTIONS IN NEODYMIUM COMPOUNDS USING THE MOESSBAUER EFFECT. Parker, F. T.; Walker, J. C. (Johns Hopkins Univ., Baltimore). pp 853-9 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Observed magnetic hyperfine fields in Nd compounds and some ^{145}Nd Moessbauer spectra are given. The studies reported indicate that the heavy rare earth saturation fields can be explained on the basis of cubic symmetry. Predictions are given of the reduced hyperfine fields for $DyAl_2$ and $ErAl_2$. The rare-earth Ni compounds provide examples of both magnetization limits. The Moessbauer spectra for all the intermetallics except $NdNi_2$ had an anomalous central peak indicating an impurity phase. The garnet and chloride spectra indicate that the proportionality between ionic and nuclear fields does not hold for these compounds. (21 references) (D.L.C.)

22163 TEMPERATURE DEPENDENCE OF HYPERFINE FIELDS IN $DyCo_2$, $DyNi_2$, AND Dy METAL. Loh, E. (Towson State Coll., Baltimore). pp 888-9 of Hyperfine Interactions in Excited Nuclei. Vol. 3. /Goldring, Gvirol (ed.). New York; Gordon and Breach Science Publishers Inc. (1971).

From Conference on hyperfine interactions detected by nuclear radiation; Rehovot and Jerusalem, Israel (6 Sep 1970).

Temperature studies of the Moessbauer effect in $DyCo_2$, $DyNi_2$, and Dy metal are reported. The data do not agree with other work and indicate a sample dependence of the "relaxation" process. A possible explanation using regions of differing critical temperature is given. (D.L.C.)

Theory

22164 ULTRASONIC ATTENUATION AND SOUND VELOCITY OF THE EXCITONIC STATE. Maki, Kazumi; Nakanishi, Kazuo (Tohoku Univ., Sendai). J. Low Temp. Phys.; 5: No. 1, 55-70 (Jul 1971).

Ultrasonic attenuation and sound velocity of a metal in the excitonic state are investigated theoretically in the limit $ql \gg 1$ and $\omega/T_c \ll 1$, where q is the sound-wave vector, l is the electron mean-free path, ω is the phonon energy, and T_c is the transition temperature of the excitonic state. The attenuation coefficient of the longitudinal wave increases drastically upon entrance into the excitonic state, then passes a maximum and decreases exponentially as temperature tends to 0°K. The attenuation coefficient of the transverse wave, on the other hand, is described in terms of the electric conductivity in the limit $ql \gg 1$ and generally increases in the excitonic state. Furthermore, it is found that the sound velocity of the longitudinal wave increases rapidly in the excitonic state, which is a simple manifestation of the anomaly of the dielectric function in the excitonic state. (auth)

PHYSICS (THEORETICAL)

Refer also to abstracts 21345, 21395, 21433, 21512, 21515, 21548, 21553, 21554, 21963, and 22167.

22165 (NYO-3829-81) CONSTRUCTING EXAMPLES IN RELATIVISTIC CLASSICAL PARTICLE MECHANICS. Shukre, C. S. (Pittsburgh Univ., Pa. Dept. of Physics); Jordan, T. F. (Minnesota Univ., Duluth, Dept. of Physics). Oct 1971. Contract AT(30-1)-3829. 13p. Dep. NTIS.

A new method is proposed for constructing examples in relativistic classical particle mechanics, starting with the Poincarè group and space reflections as transformations of position and velocity variables for two free particles and deriving equations for Lorentz covariant position variables for two interacting particles. The advantages are that the equations do not couple the position variables of the two particles, and solutions yield the particle world lines directly. Solutions are obtained for a special case. (auth)

22166 (SC-B-710886) BIBLIOGRAPHY ON INVARIANT IMBEDDING AND RELATED TOPICS. Scott, Melvin R. (Sandia Labs., Albuquerque, N. Mex.). Jan 1972. 79p. Dep. NTIS.

A collection of 250 journal articles and books on the method of invariant imbedding and several related topics are presented. The bibliography is divided into two parts: a subject catalog and an author catalog. Each article contains the author or authors, the title, journal, volume number, year of publication, and page numbers. (auth)

22167 LEKTSII PO OPTIKE TEORII OTNOSITEL'NOSTI I KVANTOVOI MEKHANIKE. (Lectures on Optics, Theory of Relativity, and Quantum Mechanics). Mandel'shtam, L. I. Moscow; Izdatel'stvo Nauka (1972). 439p.

This book commemorates the course of lectures given by Leonid Isaakovich Mandel'shtam at Moscow State University over a period of nearly 19 years. A broad range of subjects is covered: electron and electromagnetic theory, theory of vibrations, optics, statistical physics, special theory of relativity, and quantum mechanics. (K.S.W.)

22168 CAN QUANTUM THEORY BE PRESENTED AS A CLASSICAL ENSEMBLE THEORY? Ochs, Wilhelm (Univ., Munich). Z. Naturforsch.; 26a: No. 10, 1740-53(Oct 1971).

The possibility of reformulating quantum theory (QT) as a deterministic ensemble theory which (a) interprets observables as objective properties of physical systems and (b) coincides with QT in all quantitative statements is examined. As will be demonstrated, such an ensemble-quantum-theory (EQT) can only be constructed if one accepts a modified observable-concept, and as long as the theory of measurement is left out of account. A correct treatment of the measuring process is impossible within such an EQT. Consequently, there exist no hidden-variable theories with the properties (a) and (b). (auth)

22169 PROJECTION OPERATORS IN THE THEORY OF TWO-TIME GREEN FUNCTIONS. Ichiyanagi, Masakazu (Osaka Univ. Suita, Japan). J. Phys. Soc. Jap.; 32: No. 3, 604-9(Mar 1972).

New projection operators are introduced in the theory of two-time Green functions. The self-energy part of the Green function is expressed in terms of the random force whose time development differs from the usual one by a factor (1-P), P being the projection operator. In the case of the Bose system, the time-relaxation expression for the width function $\Gamma(k, \omega)$ of the dynamical structure factor was obtained which satisfies the sum rule by Puff. (auth)

22170 QUANTIZATION AS A PROBLEM IN EIGENPROBABILITIES. Prigogine, I.; George, Cl. (Univ. Libre, Brussels. Univ. of Texas, Austin). Physica; 56: No. 3, 329-44 (15 Dec 1971).

The usual way of quantization consists in looking for special solutions of the equation for the time evolution of quantum mechanical systems described in terms of the density matrix. It is shown that there exists an alternative method leading to quantization. In this method the eigenvalue problem is formulated in the π space alone. Systems described by the Hamiltonian $H = H_0 + \lambda H_1$ are considered where H_0 and H are assumed to be discrete. Quantization in the square root space and in the π space are shown to equivalent in simple systems. (J.F.P.)

22171 EVOLUTION OF THE QUANTUM STATES OF A HARMONIC OSCILLATOR IN A UNIFORM-TIME-VARYING ELECTRIC FIELD. Parker, G. W. (North Carolina State Univ., Raleigh). Amer. J. Phys.; 40: No. 1, 120-5(Jan 1972).

When a system of particles in a bound state is placed in an external field the quantum state of the system depends on the manner in which the field is produced. The two limiting cases of interest are the adiabatic and impulse limits. Since the system does not approach a stationary state in either limit, in general, it is necessary to consider solutions of the time dependent Schrödinger equation. An example of this approach is provided by the problem of a harmonic oscillator in a uniform, time varying electric field for which an exact solution is easy to obtain using the Magnus expansion for the evolution operator. This operator contains the position and momentum in a particularly simple way that allows it to be interpreted in terms of position and momentum shifts produced by the field. The wavefunction of the oscillator is obtained in the adiabatic and impulse limits assuming the field to be switched on in an exponential fashion. Results obtained for these two limiting cases are then shown to be independent of the manner in which the field reaches its final steady value. (auth)

22172 DERIVATION OF THE BLACKBODY RADIATION SPECTRUM BY CLASSICAL STATISTICAL MECHANICS. Theimer, O. (New Mexico State Univ., Las Cruces). Phys. Rev., D; 4: No. 6, 1597-1601(15 Sep 1971).

It is assumed that the fluctuating radiation energy density in a blackbody cavity is the sum of two stochastically independent terms: a zero-point energy density ρ_0 with Lorentz-invariant spectrum which persists at the absolute zero of temperature, and a temperature-dependent energy density ρ_T which satisfies the laws of statistical mechanics. The mean-square fluctuation $\langle(\delta\rho_T)^2\rangle$ of ρ_T is calculated from classical electromagnetic theory and is shown to depend explicitly on $\langle\rho_0\rangle$. Classical statistical mechanics leads then uniquely from $\langle(\delta\rho_T)^2\rangle$ to $\langle\rho_T\rangle$, which turns out to satisfy Planck's formula. (auth)

22173 TRANSITION RADIATION. Garibyan, G. M. (Erevan Physics Inst.). pp 509-29 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

A brief review of the theory and experimental material on transition radiation is given. The interest in the phenomenon began with its prediction by Ginsburg and Frank in 1945, which established a new type of radiation. Simple methods for ultra-relativistic particles aid in developing a solution both for one medium boundary and also for the case of a plate. (141 references, 2 figures) (K.S.W.)

22174 RESONANCE RADIATION OF RELATIVISTIC ELECTRONS IN PERIODIC NONHOMOGENEOUS MEDIA. Arutyunyan, F. R.; Nazaryan, A. A.; Torgomyan, G. B.; Frangyan, A. A. (Inst. of Physical Research, Erevan). pp 530-7 of Proceedings of the International Conference on Instrumentation for High Energy Physics. /Dzhelepov, V. P. (ed.). Moscow; Joint Inst. for Nuclear Research (1971). (In Russian).

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

An electron, after passage through a laminated medium, is deflected by a magnet; however, the radiation formed in the layered medium is detected in the direction of the original electron motion. The investigation centered on radiation in the energy region for γ-quanta of 10 to 250 keV, the latter being recorded by a total-absorption γ spectrometer with an 8-cm NaI(Tl) crystal as scintillator. A variety of laminated media was studied, each containing a fixed number of layers of a dense material (paper or organic film) of a given thickness spaced equally apart in air. The experimental data agreed well with the theory of resonance radiation. For electrons of low energies multiple electron scattering in the laminated medium was significant, and its effect produced an increase in the intensity of radiation. (4 figures) (K.S.W.)

22175 QUANTUM EFFECTS ON THE ELECTRON CORRELATION FUNCTION. Isihara, A. (Univ. of Rochester, N. Y.); Wadati, M. Physica; 57: No. 2, 237-53(15 Jan 1972).

The correlation function of a classical electron gas is evaluated explicitly for short distances in powers of a reduced distance r/a_0, where a_0 is the Bohr radius. The divergence at $r = 0$ of a classical correlation function is removed by quantum effects and the zero-distance limiting value is obtained for small and large δ where $\delta = 2\lambda/a_0$, λ being the thermal de Broglie wavelength. Similar results are obtained for quantum-mechanically degenerate cases. (auth)

22176 DYNAMICAL CORRELATION PATTERNS: A NEW REPRESENTATION OF THE LIOUVILLE EQUATION. Balescu, R. (Univ. Libre, Brussels. Univ. of Texas, Austin). Physica; 56: No. 1, 1-24(15 Nov 1971).

The reduced distribution functions characterizing a many-particle system are grouped together into a set called the "distribution vector." The BBGKY hierarchy then appears as a single matrix equation, algebraically equivalent to the Liouville equation. Each reduced distribution function is further decomposed into a "dynamical" cluster representation. Contrary to the usual representation, based on the functional form of the various terms (factorization), the new "correlation patterns" are defined by using a purely dynamical criterion: separate equations of evolution are written for the correlation patterns. These equations can again be viewed as components of the single (matrix) Liouville equation, in the correlation-patterns representation. This representation has been devised in order to be combined with the modern, very powerful methods of nonequilibrium statistical mechanics. It provides a concrete realization of the formerly developed abstract theory. There is no difficulty with the thermodynamic limit, which can be taken from the very beginning. The method is particularly well adapted to the study of inhomogeneous systems, in which case it provides a simple and clear-cut separation of inhomogeneity and correlation effects. The relation between usual ("static") and dynamic correlation patterns is studied. Finally, a diagram technique, suitable for practical calculations, is constructed. (auth)

22177 ELECTROMAGNETIC ZERO-POINT ENERGY AND RADIATION PRESSURE FOR A RECTANGULAR CAVITY. **Lukosz, W. (Eidgenoessische Technische Hochschule, Zurich). Physica; 56: No. 1, 109-20(15 Nov 1971).**

The presence of the conducting walls of a closed cavity changes the energy of the zero-point fluctuations of the electromagnetic field in free space. This electromagnetic zero-point energy (difference) ΔE is calculated for a rectangular cavity. From ΔE the pressures exerted on the cavity walls are derived, which are the differences of the radiation pressures of the electromagnetic zero-point fluctuations inside and outside the cavity, respectively. The pressures on the different walls of a noncubic cavity are not equal and may even differ in sign. For a cubic cavity of length, L, $\Delta E = 0.0916\hbar c/L$. The zero-point radiation pressure tends to expand the cubic cavity. The implication of this result for Casimir's model of the electron is discussed. (auth)

22178 NONLINEAR PROGRAMMING. Proceedings of a Symposium, Madison, Wisconsin, May 4–6, 1970. **Rosen, J. B.; Mangasarian, O. L.; Ritter, K. Publication No. 25 of the Mathematics Research Center, University of Wisconsin. New York; Academic Press, Inc. (1970). 499p. $10.50. (CONF-700520).**

Topics covered are method of centers by upper-bounding functions, new algorithm for unconstrained optimization, class of methods for nonlinear programing, algorithms based on the principle of feasible directions, numerical techniques in mathematical programing, a superlinearly convergent method for unconstrained minimization, and a second-order method for the linearly constrained nonlinear programing problem. Also treated are convergent step sizes for gradient-like feasible direction algorithms for constrained optimization, the implementation of conceptual algorithms, convex programs whose duals are linearly constrained, sufficiency conditions and a duality theory for mathematical programing problems in arbitrary linear spaces, recent results on complementarity problems, and nonlinear nondifferentiable programing in complex space. Finally, duality inequalities of mathematics and science, programing methods in statistics and probability theory, applications of mathematical programing to l_p approximation, and theoretical and computational aspects of nonlinear regression are discussed. (J.F.P.)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstract 20327.

22179 (TID-23087) DESIGN AND FEASIBILITY STUDY OF A PEBBLE BED REACTOR-STEAM POWER PLANT. (Sanderson and Porter, New York). 16 Jul 1958. Contract AT(30-1)-2095. 62p. (S and P-1963(Pt.3)). Dep. NTIS.

Declassified 4 Nov 1971.

A pebble bed reactor concept for central power station use is investigated. Work done in the field of fuel materials manufacturing, properties, and reprocessing is summarized. The research and development program needed to establish the feasibility of the concept is discussed. (H.D.R.)

22180 POWER GENERATION IN FUTURE. van Kampen, C. F. A. (N. V. Neratoom, The Hague). Ingenieur (Utrecht); 83: No. 34, A584-7(27 Aug 1971). (In Dutch).

In order to direct the development of future types of power stations, it is necessary to see clearly the relevant factors that should determine this direction. Since many powerful groups have an interest in this development, and political issues of state-independence, international cooperation, governmental grants, environmental hygiene, etc., are involved, secondary reasons are often brought forward in a way that can fool the innocent bystander. The problems that so abundantly lie across the path of this development are discussed. (auth) (Netherlands)

22181 NUCLEAR ENERGY OUTLOOK IN THE USSR. Petrosyants, Andronik. Energ. Nucl. (Paris); 13: No. 5, 360-2(Sep-Oct 1971). (In French).

A discussion is given on nuclear power stations currently existing in the USSR. The outlook in the framework of the ninth five year plan (1971-1975) is presented. The research period involving the choice of the most suitable energy reactors (in particular, slow neutrons) for industrial nuclear power stations has terminated. Fast neutron reactors have not yet been developed beyond the research stage. (France)

22182 NUCLEAR ENERGY DEVELOPMENT IN CZECHOSLOVAKIA. Barabas, Karel (Czech Atomic Energy Commission, Prague). Jad. Energ.; 17: No. 11, 361-3(Nov 1971). (In Czech).

The structural changes in the Czech power program are discussed with particular reference to the role of nuclear energy. The significance of international collaboration in this field is stressed. (tr-auth)

22183 LONG-TERM NUCLEAR POWER DEVELOPMENT. Svetlik, Jan (Power Research Inst., Prague). Jad. Energ.; 17: No. 11, 363-9(Nov 1971). (In Czech).

Basic problems in the development of Czech nuclear energy are discussed as a result of an analysis of several variants in the construction of nuclear electric power stations. A variant solution of projected nuclear power development is discussed in connection with a conceptual program for the computer NE-503. (tr-auth)

Physics and Core Engineering

Refer also to abstracts 22451 and 22452.

22184 (GEAP-13643) IMPLICATIONS OF NUCLEAR DATA UNCERTAINTIES TO LMFBR DESIGN. Greebler, P.; Hutchins, B. A.; Cowan, C. L. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). [1972]. Contract AT(04-3)-189. 35p. Dep. NTIS.

The current status of uncertainty in predicted physics parameters due to data uncertainties is reviewed and compared with the situation in 1966 and that projected for within the next two years due to anticipated data improvements. Implications of the uncertainties in the predicted physics parameters to design and operation are discussed for both a near-term LMFBR prototype or demonstration plant (~300 MW(e)) and a longer-term large (~1000 MW(e)) LMFBR plant. For the near-term plant, uncertainties in nuclear data require significant allowances to be made in the design and the operating conditions of reactor cores and of shielded reactor plant and fuel processing systems. These allowances result in direct cost increases due to overdesign of components and equipment and reduced core and fuel operating performance. Comprising the allowances has indirect cost implications due to increased risks of failure to meet plant and fuel performance objectives, and to satisfy licensed safety requirements. For the longer-term plant, data uncertainties cloud the predictions of the LMFBR reactor economy. While significant improvements in the nuclear data have been made during the past three years, the most important remaining specific data uncertainties are illustrated by their individual contributions to the computational uncertainty of selected physics parameters, and recommended priorities and accuracy requirements for improved data are presented. 65 references. (auth)

22185 INDUSTRIAL BREAKTHROUGH OF BREEDER REACTORS. Grenon, Michel. Rev. Fr. Energ.; 22: No. 234, 510-16(Sep 1971). (In French).

The American-designed light water (pressurized or boiling) reactor is the only one to have reached a stage of advanced industrial development. Some 200,000 MW are planned for this decade. The reactor does not efficiently use fissionable uranium. There is a need for less wasteful reactors (having a higher conversion rate) and breeder reactors. (France)

22186 METHODS FOR FREQUENCY RESPONSE MEASUREMENTS IN POWER REACTORS. Kerlin, T. W. (Univ. of Tennessee, Knoxville). pp 311-33 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

Small signal frequency response measurements can furnish useful information on the performance and safety of commercial nuclear power systems. Discrete level (usually binary) signals offer advantages over classical oscillator tests in terms of equipment costs and experiment duration. The properties that determine usefulness for frequency response testing are considered for several signals. These signals are the pulse, step, pseudo-random binary sequence, pseudo-random ternary sequence, n sequence, and the multifrequency binary sequence. The availability of such a large number of testing signals offers the experimenter considerable flexibility in matching the test procedure to test conditions, but the multifrequency binary signal appears to have the greatest potential of the signals considered. (auth)

22187 NUCLEAR REACTOR. Hilborn, J. W.; Lennox, C. G.; Mathers, W. G. (to Atomic Energy of Canada Ltd.). Canadian Patent 888,449. 14 Dec 1971. Priority date 21 Apr 1969, United States.

A cavity type, small reactor is moderated by a heavy water reflector-moderator in an outer shell. The reactor is contained in a core shell which is fitted with a hollow inverted liner spaced from the core shell to form an annular passageway down which incoming feed water is passed. Fuel inside the liner generates steam that passes out through the top of the shells. (F.S.A.) (Canada)

22188 CALCULATION OF EFFECTIVE CROSS SECTION IN DOPPLER RESONANCE REGION OF LARGE FAST REACTOR. Takano, Hideki; Ishiguro, Yukio (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 57-60 (Jan 1972).

Containment Systems, Waste Processing, and Radiation Protection

22189 TWO-DIMENSIONAL SHIELDING CALCULATIONS USING A COMBINATION OF DIFFUSION THEORY AND LINE-OF-SIGHT METHOD. Vossebrecker, H. (INTERATOM, Bensberg, Ger.). Atomkernenergie; 19: No. 1, 14-16(1972).

The two-dimensional shielding code DLS is described. Within material-filled regions diffusion theory is used, while cavities are treated using the line-of-sight method. Rotationally symmetrical geometries with gaps or other cavities, which often appear in practical shielding problems, can be investigated conveniently with this code. The calculation of the upper axial shield of the KNK-II reactor using DLS is described. It appears that the flux field in the upper top shield is mainly determined by the transport through the gap between the vessel and its jacket. (auth)

22190 PRESSURIZED WATER REACTOR CONTAINMENTS AND THEIR AUXILIARY ATTACHMENTS. Zabka, H. (Institut fuer Kraftwerke, Berlin). Kernenergie; 14: No. 12, 369-74 (Dec 1971). (In German).

The aspects of safety, economics and structure are described for several types of modern pressurized water reactor containments. The activity release into the environment following a loss of coolant accident is roughly evaluated and compared for several types of containment. Containment auxiliaries for reduction of activity release are presented. (16 references) (auth)

22191 NUCLEAR REACTORS. Livsey, W. O.; Young, A. G. (to English Electric Co. Ltd.). Canadian Patent 890,098. 4 Jan 1972.

The core of a nuclear reactor is contained in a concrete pressure vessel with a cylindrical vertical wall which is formed with pressure-tight penetrations extending vertically within the thickness of the wall. These penetrations are spaced circumferentially and communicate with the reactor space within the vessel only through coolant inlet and outlet ducts. Housed in the penetrations are heat exchanger units and coolant circulators. Each one is mounted coaxially below a corresponding one of the heat exchanger units. (F.S.A.) (Canada)

22192 TIME DEPENDENT PRESSURE BUILD-UP IN FULL PRESSURE REACTOR CONTAINMENTS, COMPARISON BETWEEN THEORY AND EXPERIMENT. Brosche, D. (Laboratorium fuer Reaktorregelung und Anlagensicherung, Garching, Ger. Technische Univ., Munich). Atomkernenergie; 19: No. 1, 41-7(Feb 1972). (In German).

The time dependent short-term pressure build-up following a loss-of-coolant accident at the primary system in full pressure containments of water cooled nuclear power reactors is treated. Therefore pressure-time histories calculated by the mathematical model and computer code ZOCO V have been compared with appropriate experimental results. This comparison showed good agreement between theory and experiment and gave an insight into the physical phenomena occurring during this short-term pressure build-up. (12 references) (auth)

22193 PRESSURE VESSEL. Kraemer, Wieland; Lovgren, Arne Sigvard (to Aktiebolaget Atomenergi). British Patent 1,254,042. 17 Nov 1971. Priority date 18 Jun 1968, Sweden.

PRESSURE VESSELS—design characteristics of thermal insulated steel lined prestressed concrete, for water cooled reactors

REACTORS, WATER-COOLED—pressure vessel for, design characteristics of thermal insulated steel lined prestressed concrete (D.C.C.)

22194 THERMALLY INSULATING PANELS. Farfaletti-Casali, Flaviano (to EURATOM). British Patent 1,253,800. 17 Nov 1971. Priority date 18 Nov 1969, Luxembourg.

PRESSURE VESSELS—thermal insulation for prestressed concrete, for gas cooled reactors

REACTORS, GAS-COOLED—pressure vessels for, design characteristics of thermal insulation for prestressed concrete

THERMAL INSULATION—design characteristics of prestressed concrete pressure vessel, for gas cooled reactors (D.C.C.)

Coolant System

Refer also to abstract 20154.

22195 (RD/B/N-1999) PARTICULATE BEHAVIOUR IN A SODIUM LOOP; CHEMICAL AND METALLURGICAL OBSERVATIONS. Evans, H. E.; Channing, D. A.; Whitlow, W. H.; Sealey, R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Sep 1971. 23p. Dep. NTIS (U. S. Sales Only).

Examination of the chemical composition of deposits found in a pumped sodium loop operated at temperatures up to 450°C for a period of 4000 h is reported. Examination of the loop components, by metallography and scanning electron microscopy, was carried out in order to assess the way in which these deposits were formed. The results are compared with earlier reports of deposit formation in sodium systems and are discussed in relation to possible mechanisms for deposition. (auth) (UK)

22196 MANUFACTURE OF LARGE STEEL PRESSURE VESSELS FOR NUCLEAR POWER STATIONS. Van Veen, M. C. (Rotterdam Dockyard Co., Netherlands). pp 62-74 of Modern Steam Plant Practice. London; Institution of Mechanical Engineers (1971).

Data are presented to illustrate the most important characteristics of steel pressure vessels for water-cooled nuclear steam-supply systems. Some of these characteristics, such as design pressure and temperature, internal diameter and height, location and size of nozzle penetrations, are specified by the builder of the reactor system. Other data, such as the choice of the steel quality with mechanical characteristics, flange and nozzle dimensions, are generally the supplier's responsibility. Fabrication of nuclear pressure vessels, in general, not only involves the actual manufacturing operations, such as welding and machining, but also includes design and stress analysis, material selection, and quality control in the delivery contract. (auth) (UK)

Fuels and Fuel Elements

Refer also to abstracts 20677, 20699, 20847, and 22364.

22197 (RT/FI-(71)33) BURN-UP CALCULATIONS FOR LWR FUEL ELEMENTS CONTAINING Gd POISONED PINS. Mattucci, A.; Pistella, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 18 Oct 1971. 64p. Dep. NTIS (U. S. Sales Only).

Calculation procedures are presented to evaluate for LWR's: the cell constants of a Gd poisoned cell vs. irradiation (the codes developed are presented and the best choices for all the options available in the computation are suggested); and the reactivity values and power distributions in a fuel element containing Gd poisoned pins. It is shown that the procedures suggested can give more reliable information without enlarging the computation time requested, with respect to standard methods. 12 references. (auth)

22198 CRITERIA FOR FAST BREEDER REACTOR CLADDING DESIGN. Shively, J. H.; Sayles, C. W.; Nathan, M. E. (North American Rockwell Corp., Canoga Park, Calif.). pp 66-75 of Applied Mechanics Aspects of Nuclear Effects in Materials. /Wan, Conrad C. (ed.). New York; American Society of Mechanical Engineers (1971).

From Meeting on applied mechanics aspects of nuclear effects in materials; Washington, D. C. (2 Dec 1971).

Rigorous analytical evaluation of cladding for fast breeder reactor fuel rods is required to insure attainment of fuel burnup goals at sufficiently high levels of reliability. The merits of both the life fraction and strain fraction methods for use as cladding performance failure analysis models are presented. The importance of fuel rod performance modeling codes for computing time-dependent consumed life fraction for fuel rod cladding on a core-wide basis is emphasized. Use of the reliability margin analysis method for determining the maximum number of fuel rod cladding failures for a given probability level is discussed. 10 references. (auth)

22199 PROSPECTS OF THE THORIUM CYCLE FOR HIGH TEMPERATURE REACTORS. Penndorf, K. Atomkernenergie; 19: No. 1, 48-52(Feb 1972). (In German).

The economic potentials of the thorium cycle and of the low enriched uranium cycle of the High Temperature Reactor are compared by means of several selected studies. (9 references) (auth)

22200 NUCLEAR FUEL ASSEMBLY. Mefford, Carl Rayford; Lass, James Lloyd; Smith, Bart Alan; Venier, Dominic Ambrose; Trocki, Thomas (to General Electric Co.). British Patent 1,256,198. 8 Dec 1971. Priority date 15 Aug 1969, United States.

REACTOR FUEL ELEMENTS—design characteristics of water cooled bundles of rod

REACTORS, BOILING—fuel elements for, design characteristics of bundles of rod (D.C.C.)

22201 NUCLEAR FUEL ELEMENT SPACER RETAINER. Lass, James Lloyd; Smith, Bart Alan (to General Electric Co.). British Patent 1,255,978. 8 Dec 1971. Priority date 10 Oct 1968, United States.

REACTOR FUEL ELEMENTS—spacers for water cooled bundles of rod

REACTORS, BOILING—fuel elements for, spacers for bundles of rod (D.C.C.)

22202 NUCLEAR REACTOR FUEL ASSEMBLY. Smith, Bart Alan; Lass, James Lloyd; Venier, Dominic Ambrose (to General Electric Co.). British Patent 1,255,821. 1 Dec 1971. Priority date 7 May 1968, United States.

REACTOR FUEL ELEMENTS—coolant flow deflectors for internal flow in water cooled bundle arranged rod type

REACTORS, BOILING—fuel elements for, coolant flow deflectors for internal flow in bundle arranged rod type (D.C.C.)

22203 NUCLEAR REACTOR. (to Siemens Aktiengesellschaft). British Patent 1,253,569. 17 Nov 1971. Priority date 3 May 1968, Germany.

REACTOR LOADING MACHINES—design characteristics of vertical, for gas cooled reactors

REACTORS, GAS-COOLED—core for, design characteristics of vertical

—loading machine for, design characteristics of vertical (D.C.C.)

Operation and Economics

22204 (JAERI-M-4482) SUMMARY ON THE JPDR OPERATION. Kawasaki, Minoru; Kamike, Kozo; Nakamura, Takeo;

Idei, Yoshio; Takariko, Isao (Japan Atomic Energy Research Inst., Tokyo). Jun 1971. 288p. (In Japanese). NTIS (U. S. Sales Only).

The JPDR, the first BWR-type power plant in Japan, was operated in natural circulation for about six years from the initial electric power generation on October 26, 1963 to the plant shutdown on September 1, 1969. The operation of the JPDR plant is described in detail, including the chronological diagrams of electrical and thermal outputs, operation statistics and radioactive waste data. Activities and statistics in the plant maintenance are also briefly discussed. (auth)

22205 TECHNICAL POSSIBILITIES OF APPLYING IAEA GUARANTEES TO NUCLEAR POWER PLANTS EQUIPPED WITH PRESSURIZED WATER POWER REACTORS. Skvortsov, S. A.; Miller, O. A. (Institut fuer Atomenergie, Moscow). Kernenergie; 14: No. 12, 375-7(Dec 1971). (In German).

The possibility of applying the IAEA guarantee system to pressurized water power reactors is shown. The features of these reactors essential for the guarantees are analyzed. The bases for realizing the guarantees, organizing the computations of nuclear materials, and surveying manipulations with these materials in the power plants are considered. Methods for computation and sampling inspection of amounts of nuclear materials, but also sites at which these controls should be carried out are recommended. The possibilities of estimating the efficiency of the guarantees, necessary documentation of computations and inspection techniques in nuclear power plants equipped with pressurized water reactors are discussed. (8 references) (auth)

22206 COMMISSIONING OF LARGE POWER STATIONS. Walker, F. (South of Scotland Electricity Board, Glasgow). pp 37-49 of Modern Steam Plant Practice. London; Institution of Mechanical Engineers (1971).

A definition of commissioning philosophy is given, and a summary is presented of commissioning procedures, organization, documentation, and personnel requirements. Some experiences and problems are noted concerning the commissioning of three South of Scotland Electricity Board power stations, i.e., two conventional stations and Hunterston B nuclear station. Special reference is made to chemical cleaning, steam purging, and condensate polishing followed by comments on packaged boilers, instrumentation and control equipment, load rejection tests, and special instrumentation. Finally, a brief mention is made of communications, operating instructions, and safety, and conclusions are drawn for present and future commissioning. (auth) (UK)

Safety and Siting

Refer also to abstracts 20296, 20376, 20377, 22446, and 22447.

22207 (COO-2152-2) INVESTIGATION OF PRESSURE DROPS AND HEAT TRANSFER COEFFICIENTS FOR LOSS OF COOLANT EVALUATIONS. Quarterly Progress Report, October 1-December 31, 1971. (Cincinnati Univ., Ohio. Dept. of Chemical and Nuclear Engineering). Contract AT(11-1)-2152. 6p. Dep. NTIS.

Progress on reactor coolant loss investigations is reported. Areas of study include: (1) Transient Pressure Drop; (2) Two-Phase Pressure-Drop and Flow Pattern; and (3) Transition Boiling and Reflooding Heat Transfer. (H.D.R.)

22208 (TID-25927) FAST REACTOR SITING AND SAFETY. AEC Regulatory Procedures and Views. Morris, Peter A. (Division of Reactor Licensing (AEC), Washington, D. C.). [1970]. 26p. Dep. NTIS.

The AEC regulatory procedures for obtaining construction permits and operating licenses are discussed. Specific differences for fast reactor siting and safety evaluation are described. (auth)

22209 INTERACTION OF REACTOR DYNAMICS WITH NUCLEAR SAFETY. Thompson, Theos J. (Atomic Energy Commission, Washington, D. C.). pp 1-7 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

The influence of core transient characteristics on reactor safety is discussed. Some of the investigations into various subtopics of reactor dynamics are examined, and the dynamics methods used in fast reactor safety analyses are described. (H.D.R.)

22210 RESEARCH PROGRAM FOR LMFBR SAFETY. Keiber, C. N.; Judd, A. M. (Argonne National Lab., Ill.). pp 509-23 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

A perspective view of fast reactor safety is developed, and the key problems of LMFBR safety are discussed. The parts of the research program that are most similar to work traditionally performed in university and industrial laboratories are indicated. (H.D.R.)

22211 SODIUM BOILING TRANSIENTS LEADING TO DISASSEMBLY IN OXIDE-FUELED FAST REACTORS. MacFarlane, D. R. (Argonne National Lab., Ill.). pp 525-51 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

Results are presented of theoretical calculations of the response of large oxide-fueled LMFBR's to whole-core power (reactivity ramp) and flow coast-down perturbations that result in coolant boiling. The validity of the predisassembly heat transfer and fluid flow analysis is restricted to the regime before fuel and/or cladding failure results in gross motion of fuel, other than that due to thermal expansion. The calculated reactor transients are finally terminated by a weak-explosion core disassembly. The weak-explosion calculation, in addition to providing shutdown reactivity due to core expansion, gives estimates of peak core temperatures and pressures as well as the pulse energy yield. The complete calculation of the reactor transient, including disassembly, is performed by a single code—the SAS1A computer code. The results of calculations of reactivity and flow coast-down transients for two different LMFBR core designs are presented and compared. (8 references) (auth)

Steam and Power Conversion System

22212 POWER PLANT WITH NUCLEAR REACTOR AND MHD SYSTEMS FOR GENERATING POWER. Radebold, Reinhart. British Patent 1,253,650. 17 Nov 1971. Priority date 16 Sep 1969, Germany.

MAGNETOHYDRODYNAMIC GENERATORS—design characteristics of liquid metal cooled power reactors with
REACTORS, LIQUID METAL-COOLED—power conversion system for, design characteristics of magnetohydrodynamic
REACTORS, POWER—power conversion system for liquid metal cooled, design characteristics of magnetohydrodynamic (D.C.C.)

22213 POWER PLANTS. Bell, Alan (to Foster Wheeler John Brown Boilers Ltd.). British Patent 1,263,473. 9 Feb 1972. Filed 31 May 1968.

Reference is made to steam turbine power plants. It is very undesirable that excessive condensation of steam should occur in the turbine stages, and particularly the higher pressure stages, since water droplets can cause severe damage to the turbine blades. Whereas this problem can be easily overcome with conventional fuel fired boilers, it can be more difficult in the case of nuclear steam generators. Another problem arising is contamination of the steam with non-condensable gases such as O_2, N_2 and CO_2. In the system described the steam is reheated between a higher pressure turbine stage and a lower pressure stage by heat exchange with a portion of the live steam; a substantial excess of live steam over that which will condense during the heat exchange is used in this heat exchange step, so as to prevent accumulation of non-condensable gases, and the excess vapor consisting of excess steam together with any non-condensable gases is separated from the condensed water, and both the separated excess vapor and the separated water are then used in the power plant. Several alternative flow arrangements may be used. The steam removed from the turbine may be dried to remove any condensed water droplets. (UK)

Commercial Power Reactors

Refer also to abstract 20823.

22214 (DOCKET-50263-112) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Supplemental Information on the Variation in Core Reactivity Calculation. (Northern States Power Co., Minneapolis, Minn.). 29 Feb 1972. 3p. Dep. NTIS.

22215 (DOCKET-50280-71) SURRY POWER STATION, UNITS 1 AND 2. Environmental Report Supplement, Revision 1. (Virginia Electric and Power Co., Richmond). 3 Mar 1972. 88p. (DOCKET-50281-68). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Environmental aspects of transmission lines are described. (D.C.C.)

22216 (FIND-50361(2-72)) FIND: SAN ONOFRE NUCLEAR GENERATION STATION, UNITS 2 AND 3. Smith, James G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 29 Feb 1972. 18p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

22217 (NP-19184) NEW APPROACH TO REACTOR LICENSING. Interim Report. (Atomic Industrial Forum, Inc., New York). 18 Jun 1971. 48p.

A number of preliminary recommendations for changes in reactor licensing practices and procedures are presented. The recommendations are the result of meetings by a lawyers group to assess the licensing situation and consider Federal and State developments which may have an impact on reactor licensing. (H.D.R.)

22218 ATOMIC AND LEGAL AUTHORIZATION PROCEDURES FOR THE KWW. EXPERIENCE RECEIVED FROM THE WUERGASSEN PROJECTS. Essmann, J. (Preussische Elektrizitaet AG, Hanover). Atomwirt., Atomtech.; 17: No. 2, 122-4(Feb 1972). (In German).

The 670 MW nuclear power installation at Wuergassen is one of the first commercial plants in the West German Republic. The evolution of authorization procedure in connection with building the reactor is reported. The original proposal by Preussenelektra on 19 July 1967, the conditions of authorization, and difficulties encountered are described. (K.S.W.)

22219 NUCLEAR POWER PLANT AT WUERGASSEN: CONCEPTION AND TECHNICAL DATA. Gersten, W. (Preussische Elektrizitaets AG, Hanover). Atomwirt., Atomtech.; 17: No. 2, 87-97(Feb 1972). (In German).

The KWW nuclear power plant and auxiliary systems are examined in detail. Cross section sketches and schematic diagrams supplement the discussion of the siting at Wuergassen, steam generation, cooling system, and electrical installation. The basic characteristics of the fuel cycle are set forth. The core contains 444 fuel element bundles, each with 49 fuel rods, with a total of 86 tons of uranium, 2.2% enriched ^{235}U. Reactor specifications data are presented on fuel and control rods, neutron fluxes, steam and thermohydraulic systems, auxiliary equipment, emergency cooling, and electrical generation. (K.S.W.)

22220 PLANNING, CONSTRUCTION, AND START-UP OF THE KWW REACTOR. Koch, M.; Vennenmann, J. (Kraftwerk Union AG, Frankfurt am Main). Atomwirt., Atomtech.; 17: No. 2, 98-102(Feb 1972). (In German).

The organization of the primary industrial contractors is considered. Six months of intensive preplanning was followed by 48 months of actual construction. Special difficulties encountered during this period are presented in outline form and classified under the headings: preparation deadlines, reactor pressure vessel, conduit assembly, automation, and turboset testing. A chronological outline of the course of the entire operation beginning in July 1967, summarizes the numerous steps of planning, construction, testing, and start-up of the reactor at Wuergassen. (K.S.W.)

22221 TRAINING OF OPERATING PERSONNEL FOR THE KWW REACTOR. David, H. (Preussische Elektrizitaets AG, Hanover). Atomwirt., Atomtech.; 17: No. 2, 120-2(Feb 1972). (In German).

Operator training for the KWW reactor is organized into eight divisions, beginning with general nuclear technology and passing through policy and practice in other atomic power plants to collaboration in pretesting and start-up of the KWW reactor at Wuergassen. The topics of heat dissipation, ionizing radiation, the physical basis of nuclear reactors. Safety practices, and fuel cycles are covered in the course. Special training is offered as needed in chemistry, physics, maintenance, and instrumentation. (K.S.W.)

22222 START-UP OF THE 60-MW POWER REACTOR (KWW, WUERGASSEN). Suchanek, W. (Preussische Elektrizitaets AG, Hanover). Atomwirt., Atomtech.; 17: No. 2, 86 (Feb 1972). (In German).

The increased power requirements of Germany and the decision in 1967 to build the KWW reactor at Wuergassen are summarized. Criticality was achieved on 22 October 1971. Introductory remarks to the series of technical papers which follow are offered. These papers treat the following topics in connection with the KWW: total conception, planning, construction, start-up of the reactor, containment safety and testing, emergency systems including that of cooling water, treatment of radioactive materials at the KWW, personnel training, and legal and publicity aspects. (K.S.W.)

22223 FRENCH INDUSTRIAL EXPERIENCE IN LIGHT WATER NUCLEAR REACTOR CONSTRUCTION. Bebin, J.; Coudray, M.; Elkouby, A.; Leny, J. C. (Framatome, Courbevoie, France). Energ. Nucl. (Paris); 13: No. 5, 331-43(Sep-Oct 1971). (In French).

The construction of the Fessenheim nuclear plant (the first light water plant of the French nuclear electricity program) was commissioned a year ago by Electricite de France. The nuclear reactor, which is of the pressurized-water type, is being manufactured by a group of French companies under the leadership of Framatome. It is shown how through the Franco-Belgian cooperation over the last ten years the Framatome/Creusot-Loire group is now in a position to build nuclear reactors at competitive prices on the international market. The experience already gained by these manufacturers in constructing the Franco-Belgian nuclear plants at Chooz and Tihange is discussed. A detailed description of the Fessenheim reactor is given. (France)

22224 ANALYSIS OF THE PRINCIPAL HYDRAULIC INSTABILITIES AND HYDROELASTIC PROBLEMS IN PRESSURIZED WATER REACTORS. RESEARCH PROGRAM. Daubert, A.; Pugnet, L.; Boulot, F.; Warluzel, A.; Barrouillet, A. (Electricite de France, Chatou). Houille Blanche; 26: No. 5, 447-50(1971). (In French).

Severe damage to the internal components (heat shield core envelope) of the SENA and SELNI pressurized water reactors demonstrates the relevance of hydroelastic phenomena in this type of reactor. The research program undertaken by the Laboratoire National d'Hydraulique investigated flow instabilities and methods of associating them with movements of the internal structure and vibrations. The annular space between the reactor vessel and the core envelope in which the flow from the various inlets meet about the heat shield can be considered as a zone of fluctuating hydrodynamic forces. The experimental program and installations are described. (France)

22225 RESULTS OF SOME ROD DROP EXPERIMENTS IN THE REACTOR OF THE RHEINSBERG NUCLEAR POWER PLANT. Loth, K.-H. (VEB Kernkraftwerk, Rheinsberg, Ger.). Kernenergie; 14: No. 9, 283-6(Sep 1971). (In German).

Accuracy of the results of rod drop experiments is often reported to be less than that of other techniques of reactivity measurement, especially for large reactors. This is due to the general suggestion that the neutron flux for all points of the reactor core decays according to the same function of time. However, studies have shown that the normal distribution may essentially change and that this is the reason for insufficient results. The results can essentially be improved if experimental counting rates or ionization chamber current before rod drop is corrected by a factor depending on relative distribution of neutron flux before and after rod drop and on location of the detector. The results of some rod drop experiments without and with correction are given, and a comparison of the efficiencies obtained in measurements on a physical test stand or during physical startup of the Rheinsberg nuclear power plant is made. (4 references) (auth)

22226 HIGH PRESSURE WATER COOLED REACTOR FOR DUTCH POWER STATION. Elec. Times; 161: No. 6, 45-6 (10 Feb 1972).

Holland's second nuclear station at Borssele, Zeeland, is a 477MW(e) PWR. Brief descriptions are given of the station layout, fuel elements, control elements, coolant system, steam generators, and the safety system. (UK)

Control and Instrumentation

Refer also to abstract 20954.

22227 (GEAP-3596) TESTS OF A FULL SCALE 1/48 SEGMENT OF THE HUMBOLDT BAY PRESSURE SUPPRESSION CONTAINMENT. Robbins, C. H. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 17 Nov 1960. 97p. For Pacific Gas and Electric Co., San Francisco, Calif.

A full scale $1/48$ segment of the Humboldt Bay pressure suppression containment was built and tested. The objectives were to demonstrate the ability of the system to handle the accident predicated for the Humboldt containment design, and to obtain information on the performance. The test facility represented one of the 48 Humboldt Bay vent pipes, the portion of the suppression chamber and pool associated with it, and appropriately sized vessels representing the reactor vessel and dry well. Transient tests were conducted by heating water in the reactor vessel to 1250 psig. A rupture disk arrangement was broken allowing water and steam from the pressure vessel to flow through an orifice into the dry well. Flow proceeded from the dry well into the suppression chamber through a vent pipe which simulated the length and resistance of the Humboldt vents. Transient pressures were measured and recorded continuously at various locations. Temperatures were also measured at strategic points and recorded. Results of the tests are presented. (auth)

22228 OPERATION GUIDANCE TECHNOLOGY AT THE NUCLEAR POWER PLANT AT WUERGASSEN. Kahnert, H.; Maygatt, W. (Preussische Elektrizitaets AG, Hanover). Atomwirt., Atomtech.: 17: No. 2. 112-15(Feb 1972). (In German).

Automatic supervision of reactor operation at Wuergassen is discussed under several topical headings. Measuring equipment includes specially selected thermocouples, 12-point printing recorders, and neutron flux monitors. Control technology incorporates pressure sensors, transmitters, etc., for close supervision of the reactor complex. Reactor protection is one part of the overall reactor safety system, and is energized when conditions prevail which deviate sufficiently from normal operation. Data processing equipment consists of three computers for optimizing operating conditions, and their individual tasks are briefly described. (K.S.W.)

22229 PROCEDURE FOR REPEATED TESTING OF THE KWW REACTOR CONTAINMENT. Dittmar, H. (Preussische Elektrizitaets AG, Hanover). Atomwirt., Atomtech.; 17: No. 2, 105-9(Feb 1972). (In German).

Much of the reactor KWW containment is inaccessible for routine inspection because of radiation levels. Accessible areas are inspected visually (including optical devices), with dye and magnetic techniques, and with ultrasound. A novel testing system for checking the annular space between steel shells (200 mm), called the "Tatzelwurm," is described. So-called "null testing" was conducted prior to reactor start-up for accessibility control and checking of the testing equipment. (K.S.W.)

22230 REACTOR SAFETY CONTAINMENT AND PRESSURE REDUCTION SYSTEM IN THE KWW. Colmano, R.; Zeitzschel, G. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech.; 17: No. 2, 102-4(Feb 1972). (In German).

The steam generation system of the AEG boiling water reactor is surrounded by a spherical, gas-tight, steel containment vessel, which also encloses a pressure reduction system external to the reactor. The actual pressure-carrying steel shell is surrounded by a second gas-tight shell, and the intervening space is exhausted continually in such a manner as to prevent leakage from operation or accident to reach the atmosphere outside. The pressure reduction system design is based on the "blowdown phase" of the maximum conceivable coolant loss resulting from a disaster. Temperature and pressure profiles of this system are presented. (K.S.W.)

22231 PROCESSING OF RADIOACTIVE MATERIALS AT THE KWW REACTOR. Bindewald, H. (Kernkraftwerk, Wuergassen, Ger.); Hepp, H. Atomwirt., Atomtech.; 17: No. 2, 116-19(Feb 1972). (In German).

Purification of the reactor water at the rate of 85 tons/hr is conducted in a bypass with ion exchange resin. Waste water from certain sources is filtered and returned to storage tanks for reuse. Treatment of filtered solids and discarded ion exchange resin are dried with infrared lamps to a water content of less than 5%. The off-gas treatment is in principle that of an enormous gas chromatography operation, using activated carbon, and the treated gas is passed through a filter to catch suspended dusts. A hold-up time of 90 minutes assures that the activity of the exit gases has decreased by several orders of magnitude. (K.S.W.)

22232 SAFETY AND EMERGENCY COOLANT SYSTEM OF THE AEG-BOILING WATER REACTOR KWW. Frenkel, E.; Hurlebaus, D. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech.; 17: No. 2, 110-12(Feb 1972). (In German).

Following an emergency shutdown of the KWW reactor, a large reserve of energy must be absorbed; thus the emergency coolant system must be designed with sufficient capacity and to operate independently of other flow systems. Pressure-release devices, spray-cooling at defined rates, cold water feeding systems, and automation of these operations are discussed. Certain types of rupture of the water systems are postulated, and the operation of the emergency coolant system is depicted graphically. (K.S.W.)

22233 CALCULATION OF THE ACOUSTIC AMPLIFICATION OF COMPLEX LOOPS: APPLICATION TO THE VIBRATION OF THE EXCHANGERS OF THE CHINON 3 REACTOR. Baylac, G. (Electricite de France, Chatou); Gibert, R. J.; Livolant, M. Houille Blanche; 26: No. 5, 407-24(1971). (In French).

The acoustic response of a complex gas circuit featuring branch lines and large volumes (to which the one dimensional plane wave approximation cannot be applied) can be calculated in matrix form for very general boundary conditions, treating the large volumes by projection on the eigen modes. This is the formulation used for the Vibraphone code. The application of this code to the study of longitudinal acoustic vibrations induced by Karman streets observed in the Chinon 3 heat exchangers confirms most of the experimental results (amplified frequencies, stationary wave shape, attenuation ranges achievable with various devices) while demonstrating the limits of an exclusively acoustic investigation of such phenomena. (France)

22234 PROBLEMS POSED BY VIBRATIONS IN THE HEAT EXCHANGERS OF THE EDF3 NUCLEAR PLANT. Coursimault, J.; Chabrerie, J. (Societe Babcock-Atlantique, Paris). Houille Blanche; 26: No. 5, 429-40(1971). (In French).

Modifications made to the EDF3 plant heat exchangers in 1969 led to the occurrence of vibrations under certain operating conditions, typically in the form of acoustic resonances and mechanical vibrations in the CO_2 exchanger circuits. An account is given of the theoretical and experimental research into these effects, and the remedies adopted. The principal research and the results obtained are presented. (France)

Operation and Economics

Refer also to abstract 22206.

22235 (DOCKET-1151-52) ELK RIVER REACTOR. Status Report, November 1, 1971-February 1, 1972. (Rural Cooperative Power Association, Elk River, Minn.). 15 Feb 1972. 8p. Dep. NTIS.

22236 (DOCKET-1155-163) LA CROSSE BOILING WATER REACTOR. Technical Specifications, Change No. 5. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Feb 1972. 12p. Dep. NTIS.

Revised technical specifications are presented concerning the maximum allowable leak rate and inservice inspection program for primary cooling system. (D.C.C.)

22237 (DOCKET-50003-100) INDIAN POINT STATION, UNIT 1. Technical Specifications, Change No. 43. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Feb 1972. 3p. Dep. NTIS.

Revised technical specifications are presented concerning leak rate limits for the primary cooling system. (D.C.C.)

22238 (DOCKET-50003-101) INDIAN POINT STATION, UNIT 1. Shutdown Not Initiated Immediately Following Turbine Trip. (Consolidated Edison Co. of New York, Inc., New York). 6 Mar 1972. 3p. Dep. NTIS.

22239 (DOCKET-50003-102) INDIAN POINT STATION, UNIT 1. One of Two Full-Size Pumps Failed to Meet Performance Specifications. (Consolidated Edison Co. of New York, Inc., New York). 13 Mar 1972. 2p. Dep. NTIS.

Failure to meet performance specifications of one of the two full-size pumps of the emergency primary makeup system is described. Required maintenance to correct the low flow performance is discussed. (D.C.C.)

22240 (DOCKET-50016-150) ENRICO FERMI ATOMIC POWER PLANT. Technical Specifications, Change Requested. (Power Reactor Development Co., Detroit, Mich.). 8 Feb 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning the atmosphere requirements below the reactor building floor during maintenance. (D.C.C.)

22241 (DOCKET-50016-151) ENRICO FERMI ATOMIC POWER PLANT. Technical Specifications Changes Requested, Below Floor Atmosphere and Syphon Breakers. (Power Reactor Development Co., Detroit, Mich.). 16 Feb 1972. 3p. Dep. NTIS.

Revised technical specifications are presented concerning the atmosphere requirements below the reactor building floor during maintenance and test requirements for syphon breakers. (D.C.C.)

22242 (DOCKET-50029-169) YANKEE NUCLEAR POWER STATION. Technical Specifications, Change No. 96 Authorized. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Feb 1972. 3p. Dep. NTIS.

Revised technical specifications are presented concerning requirements for leaks in the primary cooling system. (D.C.C.)

22243 (DOCKET-50133-79) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Operations Report, Semiannual, July 1, 1971-December 31, 1971. (Pacific Gas and Electric Co., San Francisco, Calif.). 28 Feb 1972. 28p. Dep. NTIS.

22244 (DOCKET-50155-101) BIG ROCK POINT NUCLEAR PLANT. Plans for Periodic Testing. (Consumers Power Co., Jackson, Mich.). 23 Feb 1972. 3p. Dep. NTIS.

22245 (DOCKET-50155-103) BIG ROCK POINT NUCLEAR PLANT. Operations Report, Semiannual, July 1, 1971-December 31, 1971. (Consumers Power Co., Jackson, Mich.). 28 Feb 1972. 38p. Dep. NTIS.

22246 (DOCKET-50155–104) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Change No. 29, Authorized Delay in Performance of Tests. (Division of Reactor Licensing (AEC), Washington, D. C.). 3 Mar 1972. 1p. Dep. NTIS.

22247 (DOCKET-50155–105) BIG ROCK POINT NUCLEAR PLANT. Loss of an Off-Site Power Incident on January 25, 1972. (Consumers Power Co., Jackson, Mich.). 3 Mar 1972. 8p. Dep. NTIS.

22248 (DOCKET-50206–149) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Recommended PWR Inspection Program Started. (Southern California Edison Co., Rosemead, Calif.). 23 Feb 1972. 1p. Dep. NTIS.

22249 (DOCKET-50206–150) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Report on Two Fuel Rod Failures. (Southern California Edison Co., Rosemead, Calif.). 11 Feb 1972. 4p. Dep. NTIS.

22250 (DOCKET-50206–151) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Semiannual Operating Report No. 9, July 1–December 31, 1971. (Southern California Edison Co., Rosemead, Calif.). 25 Feb 1972. 10p. Dep. NTIS.

22251 (DOCKET-50219–169) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Loss of 125V DC Bus A, February 3, 1972. (Jersey Central Power and Light Co., Morristown, N. J.). 23 Feb 1972. 2p. Dep. NTIS.

22252 (DOCKET-50219–172) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Application for Reactor Construction Permit and Operating License. (Jersey Central Power and Light Co., Morristown, N. J.). 6 Mar 1972. 392p. Dep. NTIS.

Additional information is presented concerning design parameters and operations aspects of the reactor. The information is submitted as a requirement for a full term operating license. (D.C.C.)

22253 (DOCKET-50219–173) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Failure of Scram Dump Volume Level Switch. (Jersey Central Power and Light Co., Morristown, N. J.). 10 Mar 1972. 2p. Dep. NTIS.

22254 (DOCKET-50219–174) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Loss of 4160V Emergency Bus 1C. (Jersey Central Power and Light Co., Morristown, N. J.). 10 Mar 1972. 2p. Dep. NTIS.

22255 (DOCKET-50220–82) NINE MILE POINT NUCLEAR STATION, UNIT 1. Authorization Requested for Changes. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 24 Feb 1972. 16p. Dep. NTIS.

Revised technical specifications are presented concerning the core reload physics calculations for Type 2 and Type 3 fuel bundles. (D.C.C.)

22256 (DOCKET-50220–85) NINE MILE POINT NUCLEAR STATION. Semiannual Report of Operations, July 1–December 31, 1971. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 10 Mar 1972. 2p. Dep. NTIS.

A correction in the title of a radiation dose table is presented. (D.C.C.)

22257 (DOCKET-50237–218) DRESDEN NUCLEAR POWER STATION, UNIT 2. Unoperable Refueling Interlock. (Commonwealth Edison Co., Chicago, Ill.). 29 Feb 1972. 1p. Dep. NTIS.

22258 (DOCKET-50237–219) DRESDEN NUCLEAR POWER STATION, Unit 2. Technical Specifications, Proposed Change No. 9, Unit 3. Technical Specifications, Proposed Change No. 18. (Commonwealth Edison Co., Chicago, Ill.). 1 Mar 1972. 2p. (DOCKET-50249–120). Dep. NTIS.

Revised technical specifications are presented concerning control rod drive maintenance procedures. (D.C.C.)

22259 (DOCKET-50237–220) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Semiannual Report, July 1–December 31, 1971. (Commonwealth Edison Co., Chicago, Ill.). 1 Mar 1972. 213p. (DOCKET-50249–121). Dep. NTIS.

22260 (DOCKET-50237–221) DRESDEN NUCLEAR POWER STATION, UNIT 2. Failure of a Limit Switch Resulted in an Inoperable Refueling Interlock. (Commonwealth Edison Co., Chicago, Ill.). 6 Mar 1972. 1p. Dep. NTIS.

22261 (DOCKET-50244–91) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Provisional Operating License No. DPR-18, Amendment No. 2 With Change No. 6, Technical Specifications. (Division of Reactor Licensing (AEC), Washington, D. C.). 1 Mar 1972. 229p. Dep. NTIS.

Revised technical specifications are presented for operating power levels up to 1520 MW(t). (D.C.C.)

22262 (DOCKET-50245–116) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrences AO-72-1, AO-72-2, AO-72-3, AO-72-4, and AO-72-5. (Millstone Point Co., Hartford, Conn.). 15 Feb 1972. 8p. Dep. NTIS.

The abnormal occurrences described include: incorrect pressure across the main steam line flow restrictors; failure of pressure switch for the low pressure coolant injection valve interlock; a clogged filter in the electric pressure regulator final pilot valve; failure of the gas turbine to complete a start sequence; and incorrect setpoints for the automatic pressure relief valves. (D.C.C.)

22263 (DOCKET-50245–118) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrences AO-72-6, AO-72-7, and AO-72-8. (Millstone Point Co., Hartford, Conn.). 28 Feb 1972. 4p. Dep. NTIS.

Abnormal occurrences are described concerning the incorrect trip setpoints for the condenser low vacuum reactor trip sensors and the incorrect trip setpoints for the main steam line low pressure primary containment isolation sensors. (D.C.C.)

22264 (DOCKET-50245–119) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Information Concerning Failure of Main Steam Isolation Valve Position Switch. (Millstone Point Co., Hartford, Conn.). 28 Feb 1972. 1p. Dep. NTIS.

22265 (DOCKET-50247–65) INDIAN POINT NUCLEAR GENERATING UNIT 2. Pressure Surges Within the Reactor Coolant System. (Consolidated Edison Co. of New York, Inc., New York). 28 Feb 1972. 4p. Dep. NTIS.

22266 (DOCKET-50249–119) DRESDEN NUCLEAR POWER STATION, UNIT 3. Safety Valve Operation Following a Feedwater Transient. (Commonwealth Edison Co., Chicago, Ill.). 22 Feb 1972. 25p. Dep. NTIS.

22267 (DOCKET-50250–70) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Supplement No. 45. (Florida Power and Light Co.). 29 Feb 1972. 2p. (DOCKET-50251–59). Dep. NTIS.

Estimated average annual costs for operating Turkey Point Power Reactor Units 3 and 4 are presented. (D.C.C.)

22268 (DOCKET-50250–74) TURKEY POINT PLANT, UNIT 3. Incident Report on Safety Valve Headers, December 1971, Revised. (Florida Power and Light Co.). 8 Mar 1972. 6p. Dep. NTIS.

22269 (DOCKET-50250–75) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Supplement 48. (Florida Power and Light Co.). 7 Mar 1972. 2p. (DOCKET-50251–62). Dep. NTIS.

Additional data are presented concerning the estimated average annual costs for operating the reactors. (D.C.C.)

22270 (DOCKET-50250–76) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Supplement 49. (Florida Power and Light Co.). 8 Mar 1972. 3p. (DOCKET-50251–63). Dep. NTIS.

Additional information is presented concerning interlocked valve positions for separating the cooling system from the residual heat removal system. (D.C.C.)

22271 (DOCKET-50250–77) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Supplement 50. (Florida Power and Light Co.). 10 Mar 1972. 5p. (DOCKET-50251–64). Dep. NTIS.

Additional information is presented concerning interlocked valve positions for separating the cooling system from the residual heat removal system. Revised test requirements are also presented. (D.C.C.)

22272 (DOCKET-50254–68) QUAD-CITIES STATION, UNIT 1. Semiannual Report, October 1–December 31, 1971. (Commonwealth Edison Co., Chicago, Ill.). 29 Feb 1972. 152p. Dep. NTIS.

22273 (DOCKET-50254–69) QUAD-CITIES STATION, UNIT 1. Refueling Interlock Failure. (Commonwealth Edison Co., Chicago, Ill.). 8 Feb 1972. 1p. Dep. NTIS.

22274 (DOCKET-50254–70) QUAD-CITIES STATION, UNIT 1. Several Relay Coils Open and Fuse Operated by Overload During Test. (Commonwealth Edison Co., Chicago, Ill.). 13 Mar 1972. 1p. Dep. NTIS.

22275 (DOCKET-50255–72) PALISADES PLANT. Operations Report, Semiannual, July 1–December 31, 1971. (Consumers Power Co., Jackson, Mich.). 28 Feb 1972. 60p. Dep. NTIS.

22276 (DOCKET-50255–74) PALISADES PLANT. Containment Building Post-Tensioning System One-Year Surveillance.

(Consumers Power Co., Jackson, Mich.). 2 Mar 1972. 81p. Dep. NTIS.

22277 (DOCKET-50255-75) PALISADES PLANT. Special Report No. 2, Twenty-Percent Power Escalation Physics Testing. (Consumers Power Co., Jackson, Mich.). 28 Feb 1972. 11p. Dep. NTIS.

22278 (DOCKET-50255-77) PALISADES PLANT. Interim Provisional Operating License DPR-20, Amendment 2. (Division of Reactor Licensing (AEC), Washington, D. C.). 10 Mar 1972. 218p. Dep. NTIS.

Additional information required for a provisional operating license is presented. (D.C.C.)

22279 (DOCKET-50261-87) H. B. ROBINSON UNIT NO. 2. "2A" Diesel, Failure to Start in Test. (Carolina Power and Light Co., Raleigh, N. C.) 25 Feb 1972. 2p. Dep. NTIS.

22280 (DOCKET-50261-88) H. B. ROBINSON UNIT 2. Plant Start-Up Test Program. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Jan 1972. 640p. (WCAP-7844). Dep. NTIS.

22281 (DOCKET-50263-110) MONTICELLO NUCLEAR GENERATING PLANT. Follow-up Report on Main Steam Isolation Valve Problem. (Northern States Power Co., Minneapolis, Minn.). 18 Feb 1972. 4p. Dep. NTIS.

22282 (DOCKET-50263-113) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Planned Modifications to the High Pressure Coolant Injection System Steam Line Flow Sensing Device. (Northern States Power Co., Minneapolis, Minn.). 2 Mar 1972. 3p. Dep. NTIS.

22283 (DOCKET-50263-114) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Steps Taken to Prevent a Recurrence of Items Discovered on Inspection. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 28 Feb 1972. 6p. Dep. NTIS.

Revised procedures are described for sampling radioactive effluents. (D.C.C.)

22284 (DOCKET-50263-115) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Six Months Operating Report 2, July 1-December 31, 1971. (Northern States Power Co., Minneapolis, Minn.). 28 Feb 1972. 139p. Dep. NTIS.

22285 (DOCKET-50269-47) OCONEE NUCLEAR STATION, UNIT 1. Structural Integrity Test of Concrete Containment Dome. (Duke Power Co., Charlotte, N. C.). 2 Mar 1972. 2p. Dep. NTIS.

22286 (DOCKET-50270-39) OCONEE NUCLEAR STATION, UNIT 2. Order Extending Provisional Construction Permit Completion Date to February 28, 1973. (Division of Reactor Licensing (AEC), Washington, D. C.). 1 Mar 1972. 2p. Dep. NTIS.

22287 (DOCKET-50271-74) VERMONT YANKEE NUCLEAR POWER STATION. Update on Status of Plant Preoperational Test Program. (Vermont Yankee Nuclear Power Corp., Rutland). 28 Feb 1972. 3p. Dep. NTIS.

22288 (DOCKET-50272-23) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Application for Licenses, Amendment 11. (Public Service Electric and Gas Co., Newark, N. J.). 1 Mar 1972. 159p. (DOCKET-50311-23). Dep. NTIS.

Financial data are presented for the owners of Salem Power Reactor Units 1 and 2. The 1970 Annual Reports for the Public Service Electric and Gas Company, the Philadelphia Electric Company, and the Delmarva Power and Light Company are included. The 1971 Annual Report for the Atlantic City Electric Company is also included. (D.C.C.)

22289 (DOCKET-50285-59) FORT CALHOUN STATION, UNIT 1. Pulling Cables by Use of Vehicles. (Omaha Public Power District, Nebr.). 4 Mar 1972. 5p. Dep. NTIS.

22290 (DOCKET-50334-29) BEAVER VALLEY POWER STATION, UNIT 1. Supplementary Report on January 3, 1972 Fire. (Division of Compliance (AEC), Washington, D. C.). 10 Mar 1972. 11p. Dep. NTIS.

Analysis of fire damage to the containment structure is presented. Required repairs are described. (D.C.C.)

22291 (DOCKET-50363-21) FORKED RIVER NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment No. 13. (Jersey Central Power and Light Co., Morristown, N. J.). 10 Feb 1972. 108p. Dep. NTIS.

Financial data for the owners of the Forked River Power Reactor Unit 1 are presented. (D.C.C.)

22292 (DOCKET-50400-11) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment No. 2. (Carolina Power and Light Co., Raleigh, N. C.). 18 Feb 1972. 70p. (DOCKET-50401-11; DOCKET-50402-11; DOCKET-50403-11). Dep. NTIS.

Additional information is presented concerning regional electric power consumers and power production costs. (D.C.C.)

22293 (NP-19206) BIG ROCK POINT NUCLEAR PLANT. Quarterly Operations Report No. 79, October-December 1970. (Consumers Power Co., Jackson, Mich.). 27p.

22294 (TID-25933) GARIGLIANO NUCLEAR POWER STATION. Operation Report for the 3rd Quarter of 1971. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 30 Sep 1971. 19p. Dep. NTIS.

22295 (TID-25936) ARDENNES NUCLEAR POWER PLANT. Report for November 1971. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 14p. Dep. NTIS.

Operations and maintenance requirements during November 1971 are described. (D.C.C.)

Safety and Siting

22296 (DOCKET-1155-164) LA CROSSE BOILING WATER REACTOR. Emergency Core Cooling System Evaluation, Interim Report, February 25, 1972. (Gulf United Nuclear Fuels Corp., Elmsford, N. Y.). 6 Mar 1972. 42p. Dep. NTIS.

22297 (DOCKET-50003-99) INDIAN POINT STATION, UNIT 1. Answers to Inquiries on Control Rods. (Consolidated Edison Co. of New York, Inc., New York, Inc., New York). 28 Feb 1972. 5p. Dep. NTIS.

Requested additional information is presented concerning safety aspects of displaced control rods. (D.C.C.)

22298 (DOCKET-50155-102) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Change No. 28 Allowed. (Division of Reactor Licensing (AEC), Washington, D. C.). 28 Feb 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning core support limits and stack release rate for ^{131}I. (D.C.C.)

22299 (DOCKET-50219-171) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Environmental Report. (Jersey Central Power and Light Co., Morristown, N. J.). 6 Mar 1972. 516p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on th environment are analyzed. Biological, geological, hydrological, and meteorological data for the reactor site are included. Cost-benefit analysis for reactor operation is presented. (D.C.C.)

22300 (DOCKET-50220-84) NINE MILE POINT NUCLEAR STATION. Technical Specifications, Proposed Changes. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 28 Feb 1972. 20p. Dep. NTIS.

Revised calculations are presented for the reactivity curve during emergency shutdown response to operational transients. (D.C.C.)

22301 (DOCKET-50237-222) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Semiannual Reports Section III, Errors. (Commonwealth Edison Co., Chicago, Ill.). 7 Mar 1972. 5p. (DOCKET-50249-122). Dep. NTIS.

Corrected data are presented concerning radioactive discharges during July to December 1971. (D.C.C.)

22302 (DOCKET-50244-92) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Technical Specifications, Change No. 3, Supporting Information. (Rochester Gas and Electric Corp., N. Y.). 29 Feb 1972. 4p. Dep. NTIS.

Performance characteristics of the residual heat removal pumps are presented. (D.C.C.)

22303 (DOCKET-50247-64) INDIAN POINT NUCLEAR GENERATING, UNIT 2. Final Facility Description and Safety Analysis Report, Changes Accepted. (Division of Reactor Licensing (AEC), Washington, D. C.). 25 Feb 1972. 4p. Dep. NTIS.

Changes in design parameters and operations aspects for the Indian Point Power Reactor Unit 2 are presented. (D.C.C.)

22304 (DOCKET-50250-69) TURKEY POINT PLANT, UNIT 3. Final Containment Dome Report. (Florida Power and Light Co.). 25 Feb 1972. 114p. Dep. NTIS.

22305 (DOCKET-50250-71) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Supplement No. 46. (Florida Power and Light Co.). 29 Feb 1972. 100p. (DOCKET-50251-60). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the reactors. (D.C.C.)

22306 (DOCKET-50250–72) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Supplement No. 47. (Florida Power and Light Co.). 3 Mar 1972. 45p. (DOCKET-50251–61). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects for the Turkey Point Power Reactor Units 3 and 4. (D.C.C.)

22307 (DOCKET-50250–73) TURKEY POINT PLANT, UNIT 3. Reactor Containment Building Integrated Leak Rate Test. (Bechtel Corp., San Francisco, Calif.). 24 Feb 1972. 295p. Dep. NTIS.

For Florida Power and Light Co.

22308 (DOCKET-50254–67) QUAD-CITIES STATION, UNITS 1 AND 2. Draft Detailed Statement on Environmental Considerations Related to the Issuance of an Operating License. (Division of Reactor Licensing (AEC), Washington, D. C.). 6 Mar 1972. 151p. (DOCKET-50265–58). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Cost-benefit analysis for the reactors is included. (D.C.C.)

22309 (DOCKET-50255–73) PALISADES PLANT. Draft Detailed Statement on Environmental Considerations Related to Proposed Issuance of an Operating License. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). 29 Feb 1972. 312p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Biological, geological, hydrological, and meteorological data on the reactor site are included. Cost-benefit analysis of reactor operation is presented. (D.C.C.)

22310 (DOCKET-50255–76) PALISADES PLANT. Safety Evaluation, Supplement 5. (Division of Reactor Licensing (AEC), Washington, D. C.). 8 Mar 1972. 6p. Dep. NTIS.

Additional information is presented concerning the performance evaluation of the emergency core cooling system. (D.C.C.)

22311 (DOCKET-50259–39) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 22. (Tennessee Valley Authority, Chattanooga). 24 Feb 1972. 102p. (DOCKET-50260–38; DOCKET-50296–36). Dep. NTIS.

Revised design parameters of the Browns Ferry Power Reactor Units 1, 2, and 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

22312 (DOCKET-50263–111) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Radwaste Effluent Data as Established by Appendix A of Safety Guide 21. (Northern States Power Co., Minneapolis, Minn.). 29 Feb 1972. 5p. Dep. NTIS.

Radioactive effluents from the reactor during January to December 1971 are listed. (D.C.C.)

22313 (DOCKET-50267–39) FORT ST. VRAIN NUCLEAR GENERATING STATION. Environmental Report, Operating License Stage, Additional Information. (Public Service Co. of Colorado, Denver). 6 Mar 1972. 5p. Dep. NTIS.

The environmental radiation monitoring program is described. (D.C.C.)

22314 (DOCKET-50269–48) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Revision No. 18. (Duke Power Co., Charlotte, N. C.). 10 Mar 1972. 207p. (DOCKET-50270–40; DOCKET-50287–36). Dep. NTIS.

Revised and additional data are presented concerning the design parameters and operations aspects of the reactors. (D.C.C.)

22315 (DOCKET-50277–42) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Amendment No. 14. (Philadelphia Electric Co., Pa.). 1 Mar 1972. 145p. (DOCKET-50278–32). Dep. NTIS.

Revised design parameters of the Peach Bottom Power Reactor Units 2 and 3 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

22316 (DOCKET-50280–70) SURRY POWER STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 32. (Virginia Electric and Power Co., Richmond). 11 Feb 1972. 145p. (DOCKET-50281–67). Dep. NTIS.

Revised design parameters and operations aspects for the Surry Power Reactor Units 1 and 2 are presented. (D.C.C.)

22317 (DOCKET-50280–72) SURRY POWER STATION, UNITS 1 AND 2. Draft Detailed Statement on Environmental Considerations Related to the Proposed Issuance of Operating Licenses. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). Mar 1972. 210p. (DOCKET-50281–69). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Biological, geological, hydrological, and meteorological data for the site are included. Cost-benefit analysis for reactor operation is presented. (D.C.C.)

22318 (DOCKET-50289–52) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Environmental Report, Amendment No. 1. (Metropolitan Edison Co., Reading, Pa.). 3 Mar 1972. 44p. (DOCKET-50320–28). Dep. NTIS.

Revised and additional data are presented concerning radioactive and thermal discharges and transmission lines. (D.C.C.)

22319 (DOCKET-50293–66) PILGRIM NUCLEAR POWER STATION. Draft Detailed Statement on the Environmental Considerations Related to the Issuance of an Operating License. (Division of Reactor Licensing (AEC), Washington, D. C.). 29 Feb 1972. 101p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Cost-benefit analysis for the reactor is included. (D.C.C.)

22320 (DOCKET-50295–43) ZION STATION, UNITS 1 AND 2. Environmental Report, Supplement No. 3. (Commonwealth Edison Co., Chicago, Ill.). 29 Feb 1972. 61p. (DOCKET-50304–43). Dep. NTIS.

Requested additional data are presented concerning calculations for gaseous and liquid radioactive effluents. (D.C.C.)

22321 (DOCKET-50298–27) COOPER NUCLEAR STATION. Final Safety Analysis Report, Amendment 9. (Nebraska Public Power District, Columbus). 9 Mar 1972. 320p. Dep. NTIS.

Requested additional data are presented concerning design parameters and operations aspects of the reactor. (D.C.C.)

22322 (DOCKET-50312–35) RANCHO SECO NUCLEAR GENERATION STATION, UNIT 1. Preoperational Radiological Environmental Monitoring and Preoperational Water Quality Monitoring Programs. (Sacramento Municipal Utility District, Calif.). 28 Feb 1972. 119p. Dep. NTIS.

22323 (DOCKET-50313–39) ARKANSAS NUCLEAR ONE, UNIT 1. Final Safety Analysis Report, Amendment No. 24. (Arkansas Power and Light Co., Little Rock). 29 Feb 1972. 109p. Dep. NTIS.

Revised design parameters of the Arkansas Nuclear One Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

22324 (DOCKET-50317–38) CALVERT CLIFFS NUCLEAR POWER PLANTS, UNITS 1 AND 2. Final Safety Analysis Report, Amendment No. 18. (Baltimore Gas and Electric Co., Md.). 3 Mar 1972. 427p. (DOCKET-50318–37). Dep. NTIS.

Revised design parameters of the Calvert Cliffs Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. Performance evaluation of the emergency core cooling system is presented. (D.C.C.)

22325 (DOCKET-50317–39) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 6, Additional Information. (Baltimore Gas and Electric Co., Md.). [1972]. 13p. (DOCKET-50318–38). Dep. NTIS.

Additional information is presented concerning quality assurance requirements for pressure vessel fabrication and radioactive effluents from primary cooling system leaks. (D.C.C.)

22326 (DOCKET-50333–39) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Supplement 5. (Power Authority of the State of New York). 10 Mar 1972. 104p. Dep. NTIS.

Revised design parameters of the James A. Fitzpatrick Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

22327 (DOCKET-50341–37) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Draft Environmental Statement Related to Proposed Construction. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). Mar 1972. 124p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Cost-benefit analysis for the reactor is included. (D.C.C.)

22328 (DOCKET-50348–36) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Environmental Report, Sup-

plement, Amendment No. 1. (Alabama Power Co., Birmingham). 28 Feb 1972. 62p. (DOCKET-50364-30). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. Cost-benefit analysis for reactor operation is included. (D.C.C.)

22329 (DOCKET-50358-33) WILLIAM H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Environmental Report, Amendment No. 3. (Cincinnati Gas and Electric Co., Ohio). 18 Feb 1972. 76p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. Meteorological data for the reactor site are included. (D.C.C.)

22330 (DOCKET-50366-23) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment No. 15. (Georgia Power Co., Atlanta). 1 Mar 1972. 70p. Dep. NTIS.

Financial data for the owners of the Edwin I. Hatch Power Reactor Unit 2 are presented. The 1970 Annual Report for the Georgia Power Company is included. (D.C.C.)

22331 (DOCKET-50382-18) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Environmental Report, Construction Permit Stage. (Lousiana Power and Light Co., New Orleans). 24 Feb 1972. 430p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Biological, geological, and hydrological data for the reactor site are included. Cost-benefit analysis for the reactor is presented. (D.C.C.)

22332 (DOCKET-50387-15) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment No. 6. (Pennsylvania Power and Light Co., Allentown). 17 Feb 1972. 57p. (DOCKET-50388-15). Dep. NTIS.

Requested additional information is presented concerning design parameters and operations aspects of the reactors. (D.C.C.)

22333 (DOCKET-50387-16) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment No. 7. (Pennsylvania Power and Light Co., Allentown). 1 Mar 1972. 69p. (DOCKET-50388-16). Dep. NTIS.

Revised and additional data are presented concerning the radioactive waste disposal system and transmission lines. (D.C.C.)

22334 (DOCKET-50395-15) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment No. 5. (South Carolina Electric and Gas Co., Columbia). 1 Mar 1972. 361p. Dep. NTIS.

Revised design parameters of the Virgil C. Summer Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

22335 (DOCKET-50397-12) HANFORD NO. 2 NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 2. (Washington Public Power Supply System, Richland). 25 Feb 1972. 627p. Dep. NTIS.

Revised design parameters of the Hanford Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

22336 (DOCKET-50400-12) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment No. 3. (Carolina Power and Light Co., Raleigh, N. C.). 1 Mar 1972. 215p. (DOCKET-50401-12; DOCKET-50402-12; DOCKET-50403-12). Dep. NTIS.

Revised design parameters of the Shearon Harris Power Reactor Units 1, 2, 3, and 4 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

22337 EIGHT YEARS EXPERIENCE IN THE PROTECTION OF PERSONNEL IN EDF NUCLEAR POWER STATIONS. Beau, P.; Martin, J. J. (Electricite de France, Paris). Energ. Nucl. (Paris); 13: No. 5, 350-9(Sep-Oct 1971). (In French).

Ideas on the protection of personnel working in nuclear power stations have evolved from more than eight years experience acquired in the nuclear field by Electricite de France. The risks involved in the operation of nuclear plants, their minimization, and the radiological protection employed by EDF power stations are discussed. (France)

22338 RADIOLOGICAL SAFETY AND SITE STUDIES. APPLICATION TO THE PHENIX REACTOR. Candes, P. (CEN de Saclay, Gif-sur-Yvette, France). Energ. Nucl. (Paris); 13: No. 5, 344-9(Sep-Oct 1971). (In French).

Nuclear reactor power station studies involve all the possible situations encountered in normal operation as well as accidents which lead to the transfer of radioactivity from the installation to the site. Such studies lead to the development of various safety equipment (primary and secondary confinement, filtration stack) designed to minimize the consequences of an accident. An appropriate choice of site (meteorology, hydrology, geology, and remoteness from populated areas) is desirable. Applications to the Phenix reactor are considered. (France)

Propulsion and Auxiliary Power Reactors

Refer also to abstract 20224.

22339 (AI-AEC-13017) SNAP REACTOR PROGRAMS PROGRESS REPORT, AUGUST-OCTOBER 1971. (Atomics International, Canoga Park, Calif.). 23 Dec 1971. Contract AT-(04-3)-701. 84p. Dep. NTIS.

Space Power Facility (SPF) reactor design and performance analyses continued on the 199-fuel-element core. Core thermal and hydraulic studies were conducted to further examine worst case core thermal conditions as the basis for fuel element and thermal stress analysis. Fin-on-tube structural tests were conducted to evaluate fin geometries and cladding contact stresses for both the Hastelloy X and Incoloy 800 fuel element configurations. The margins of safety for Hastelloy X are considerably greater in the as-fabricated conditions and the core assembly condition, as well as during normal operation. Trade-off studies were performed on burnable poisons with the results favoring a 50/50 mixture of natural Gd and ^{151}Eu for the SPF reactor. Additional NaK heat transfer testing was performed with smooth heaters simulating fuel elements spaced at a P/D of 1.05. The experimental results are in good agreement with the analytical predictions. An S8DR design actuator was subjected to vibration loads expected during launch of a Saturn V booster. No damage or effects on performance were detected at these loads or at loads several times higher. Design studies on the drum drive and launch lock mechanism, and on metallic sheathed electrical cables continue. Effort continues on evaluation of hobbing techniques, weld parameters, and final closure parameters for both Hastelloy-X and Incoloy-800-clad fuel elements. A second group of 20-mil, smooth-wall Hastelloy-X-clad elements was assembled. Mechanical and thermal testing of these fuel elements continues. Test results on the TEM-X series thermoelectric power modules continue to demonstrate the excellent performance stability of this module. Four modules have accumulated between 2500 and 4500 hours of operation at 1085°F, including thermal cycling, with essentially no power degradation. Testing of prototype pump modules is approaching 24,000 hours with total power degradation in the range of 3 to 4% per 10,000 hours. (auth)

22340 (GKSS-71/E/7) EXPERIMENTS IN REACTOR DYNAMICS ON THE FDR OF THE OTTO HAHN. Fiebig, R.; Kolb, M.; Robinson, E.; Schwieger, E. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1971. 25p. (In German). (CONF-710532-1). Dep. NTIS (U. S. Sales Only).

From Conference on nuclear ships; Hamburg, Germany (10 May 1971).

In the framework of the physics research program on the N. S. Otto Hahn, studies were performed on dynamics of the new advanced pressurized-water reactor. Two goals were pursued: first, the influence of ship movement on reactor operation was determined by means of noise analysis; and second, control behavior of the reactor was studied. To obtain a comparison with calculations on models, the reactor was operated at various power levels, sudden changes in reactivity and pressure. Reactivity equivalents of control rods were determined by means of inverse reactor kinetics. (15 references) (tr-auth)

22341 (TID-5307) PACKAGED POWER SYSTEM FOR REMOTE MILITARY BASES; SELECTION REPORT. (Martin (Glenn L.) Co., Baltimore, Md.). Oct 1955. Contract AT(11-1)-342. 51p. Dep. NTIS.

The study of all reasonable methods for employing nuclear energy at remote military bases led to the selection of the air cycle reactor power plant. The choice results from authentic advantages of the air cycle relative to other systems for this application. The air cycle plant has a solid supporting technology. It is designed using a minimum of components and is relatively light in weight. The system promises the earliest development for remotely located, unattended power plants in the 100 kilowatt power range. (auth)

22342 (TID-12535) HEAT-TRANSFER PHENOMENA IN THE NOZZLE OF A NUCLEAR ROCKET. Report No. 1211. Beereboom, J. J.; Greenberg, A. B.; Mandell, B. (Aerojet-General Corp., Azusa, Calif.). 27 Dec 1956. Contract W-7405-eng-48. 86p. Dep. NTIS.

For California Univ., Livermore. Radiation Lab.

Studies were performed of the heat transfer in the nozzle of a nuclear rocket; in addition to the convective heat, the heating effects of thermal and nuclear radiation were considered. It is shown that the large convective heat flux that occurs when hydrogen is the propellant may seriously aggravate the problem of adequately cooling the nozzle by regenerative methods. A parametric technique for predicting the weight of a rocket nozzle is presented, and the considerations influencing the choice of a nozzle of minimum weight are indicated. The technology of film- and transpiration-cooling techniques is reviewed, and the development problems associated with such techniques are discussed. Specific experimental and analytical programs are recommended for obtaining information that will form the basis of the development of a nozzle for a nuclear rocket. (28 references) (auth)

22343 (WKNL-62) DESIGN CRITERIA FOR A FULL POWER TEST FACILITY. Frankfort, J. H. (Kidde (Walter) Nuclear Labs., Inc., Garden City, N. Y.). 20 Jun 1956. Contract AT-(11-1)-229. 133p. Dep. NTIS.

For Pratt and Whitney Aircraft, East Hartford, Conn.

Declassified 18 Oct 1971.

The Full Power Test Facility described will furnish data on the nuclear and process characteristics of an aircraft-prototype, circulating-fluoride fuel reactor operating at a power level of 300 MW. Operation of this facility chronologically follows operation of the Low Power Test Facility in the nuclear aircraft development program. The facility design criteria given do not represent a completely finalized set of specifications. Rather, they are intended to furnish sufficient information to enable establishment of the final design. The specifications given cover the equipment necessary for operation of the reactor and for removal of the heat generated in the fuel. (auth)

22344 NUCLEAR PROPULSION FOR SHIPS. VI. DEVELOPMENT OF PROPULSION EQUIPMENT AND THE AUTOMATION OF THE ELECTRICITY POWER PLANT. Dequenes, P.; Clement, P.; Baude, P. Rev. Gen. Elec.; 80: No. 10, 752-60 (Oct 1971). (In French).

The propulsion system used in nuclear ships is described. The dimensions and operating conditions associated with the use of vapor of nuclear origin and the way in which the risks due to radioactive contamination of the secondary circuits are minimized are discussed. A procedure for ensuring the propulsion of the ship (at reduced speed), and the production vapor in the event of reactor failure is discussed. The development of the electric power plant is studied. The equipment and the electric generators are described and the continuous operating conditions examined. The automation of the propulsion system and the control monitoring system are presented. (France)

22345 NUCLEAR PROPULSION FOR SHIPS. I. PHILOSOPHY AND SPECIFIC PROBLEMS CONCERNING NUCLEAR PROPULSION. Bonnet, Y. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Gen. Elec.; 80: No. 10, 721-3(Oct 1971). (In French).

The advantages of nuclear propulsion over conventional propulsion are discussed. The type of PWR reactor used aboard nuclear ships is described. (France)

Control and Instrumentation

22346 (TID-14874) PRELIMINARY TRIPLE FLANGE TEMPERATURE DISTRIBUTIONS. (Aircraft Armaments, Inc., Cockeysville, Md.). 27 Jul 1959. Contract AT(11-1)-171. 36p. (ER-1745). Dep. NTIS.

For Aircraft Nuclear Propulsion Dept., General Electric Co., Cincinnati, Ohio.

Declassified 19 Oct 1971.

Computer calculated values were used to plot curves of XMA front shield plug temperature distribution in the triple flange region. (W.E.B.)

22347 (TID-19488) DESCRIPTION AND PERFORMANCE CHARACTERISTICS OF TWO ELECTROPNEUMATIC CONTROL DRUM ACTUATION SYBSYSTEMS. Report No. 2430. (Bendix Corp., South Bend, Ind. Bendix Products Aerospace Div. Bendix Corp., Southfield, Mich. Research Labs. Div.). Oct 1963. Contract W-7405-eng-36. 70p. Dep. NTIS.

For Los Alamos Scientific Lab., N. Mex. Declassified 21 Oct 1971.

The Control Drum Actuation Subsystem is a closed loop electropneumatic rotary position servo consisting of one actuator and a servo amplifier. The actuator adjusts the power level of the reactor by rotating the reactor control drum in response to engine control system command signals to the servo amplifier. Performance test results on the subsystem are presented. (auth)

22348 NUCLEAR PROPULSION FOR SHIPS. V. PRESSURE, LEVEL, AND FLOW SENSORS FOR LIGHT WATER PROPULSION REACTORS. Deniau, P. (Etablissements Jules Richard, Paris). Rev. Gen. Elec.; 80: No. 10, 747-51(Oct 1971). (In French).

Two types of pressure sensors are described: those with a linear output signal and those with a quadratic output signal. The performance of these devices is presented. Two hundred devices were constructed. They are reliable under the most severe environmental conditions. (France)

22349 NUCLEAR PROPULSION FOR SHIPS. IV. EXAMPLES OF SAFETY SYSTEMS FOR NUCLEAR PROPULSION REACTORS. Laubie, J. C. (Etablissements Merlin et Gerin, Grenoble, France). Rev. Gen. Elec.; 80: No. 10, 741-6(Oct 1971). (In French).

The organization of a safety system is described; the operation of the system is analyzed. A system incorporating magnetic elements was developed. This system protects the equipment against unexpected failures. (France)

22350 NUCLEAR PROPULSION FOR SHIPS. III. SAFETY AND CONTROL MONITORING EQUIPMENT FOR THE NUCLEAR BOILER PLANTS ABOARD SHIPS. Mocquard, A. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Gen. Elec.; 80: No. 10, 733-40(Oct 1971). (In French).

Specific problems relating to nuclear propulsion are recalled. An analysis of the main parameters which must be controlled in the nuclear boiler plant of a ship is presented. A control and monitoring system is described as well as the tests carried out before installing the equipment aboard the ship. (France)

Operation and Economics

22351 (GKSS-71/E/6) N. S. OTTO HAHN. APPROVAL TEST REPORT NO. 15 CARGO AND RESEARCH VOYAGE (TRIP NO. 45-51) IN THE TIME FROM AUGUST 31-DECEMBER 16, 1970 TO DAKAR, LOME-KPEME AND CASABLANCA. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1971. 43p. (In German). Dep. NTIS (U. S. Sales Only).

In the last quarter of 1970, the N. S. Otto Hahn conducted five voyages over a total distance of 19,493 nautical miles with a cargo of 39,600 tons of phosphate. During the period the reactor operated reliably and free of disturbances. Slight contamination of the primary cooling water could be traced to a filter defect which was corrected. Research was performed on oscillations in various parts of the ship. Also measured was the effectiveness of the reactor shield. During the last voyage, an extensive study of reactor dynamics was conducted with respect to xenon poisoning, control rods, and power. Also studied were the basic dynamics of the heat exchanger for the purpose of obtaining information about future designs. Careful checks of the ballast tanks showed no corrosion. (H.B.G.)

Safety

Refer also to abstract 20197.

22352 NUCLEAR PROPULSION FOR SHIPS. II. ANALOGICAL STUDIES OF THE BOILER OF A NUCLEAR PROPULSION UNIT. Boulven, J. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Gen. Elec.; 80: No. 10, 724-32(Oct 1971). (In French).

The applications of analog calculations in solving problems relating to nuclear boiler plants aboard ships are justified. The main advantages of this sort of calculation are presented. A scheme is given for the installation. The procedures adopted and the sequence of operations carried out during the simulation (construction of the physical model, establishment of the physical equations, deduction of the analog equations, wiring of the analog diagram, and the acquisition and interpretation of the results) are described. Three examples of simulated interference are given and illustrated by diagrams and graphs. (France)

Process Heat and Desalination Reactors

22353 (NP-19189) U. S. PATENT ABSTRACTS AND INDEXES COVERING THE TECHNOLOGY OF DISTILLATION PRO-

CESSES FOR SALINE WATER CONVERSION. Research and Development Progress Report No. 732. Johnsson, K. O.; Hammond, R. P.; O'Meara, J. W.; Tomalin, Paul G. (Office of Saline Water, Washington, D. C.). Jul 1971. 91p. GPO $1.00.

Abstracts are given for approximately 400 U.S. patents pertaining to the distillation process for converting seawater or brackish water to potable water. The abstracts are part of a computerized storage and retrieval system operated for the Office of Saline Water by the Oak Ridge National Laboratory. The patents are indexed by keywords, patentees, and patent numbers. (auth)

Operation and Economics

22354 INVESTIGATION OF THE POTENTIALITIES OF NUCLEAR ENERGY IN THE INDUSTRIAL HEAT MARKET. Thiriet, L. (CEN, Fontenay-aux-Roses, France). Energ. Nucl. (Paris); 13: No. 5, 370-4(Sep-Oct 1971). (In French).

The outlook for the exploitation of nuclear energy in the low temperature heat market is discussed. The intrinsic economic advantages of nuclear energy in this field and the possible developments are envisaged. (France)

Research and Test Reactors

Refer also to abstracts 20417 and 22431.

22355 (CNEA-303) EXPERIMENTAL-THEORETICAL CORRELATION IN THE RA-3 REACTOR. Pasquini, E.; Pieroni, N.; Rapoport, H.; Ricabarra, G.; Solanilla, R. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1971. 47p. (In Spanish). (CONF-690734-1). Dep. NTIS (U. S. Sales Only).

From Conference of physic association; La Plata, Argentina (28 Jul 1969).

The fundamental prompt neutron decay constant of a multiplying system can be obtained by pulsed neutron methods. This is a parameter independent of any theoretical definition. It is also a convenient experimental quantity to be compared with values obtained by calculation. Experimental decay values for different configurations of the RA-3 reactor are compared with those obtained by a two group diffusion theory calculation using modified cross section data. The agreement is excellent, even for high subcritical states of the system. This calculational method with the associated data can predict reactivities for the core of the RA-3 reactor with reasonable accuracy. The practical importance of the method is the possibility of applying it using a small computer for the calculations. 29 references. (auth)

22356 (FMRB-38/71) DETERMINATION OF THE REACTIVITY OF A WEAKLY COUPLED TWO-ZONE ARRAY. Roethemeyer, Helmut (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Dec 1971. 97p. (In German). Dep. NTIS (U. S. Sales Only).

The "Research and Measuring Reactor" (FMRB) is operated with two MTR-Cores weakly coupled by a heavy water tank. The properties of this configuration have been investigated by applying pulsed source and asymptotic period techniques. Reactivities determined by pulsed source measurements display large statistical uncertainties. This is due to delay-time dependent coupling effects. The errors can be avoided by determining the reactivities of the two uncoupled (isolated) cores and calculating their influence on the coupled core configuration with a two point reactor model. The period method of determining reactivity is applicable with the same accuracy as in single core reactors. The influence of reactivity perturbations depends on the power ratio of the two cores, but is always less than the effect of the same perturbation in the single isolated cores. The measured reactivity-properties are in agreement with the predictions of a two point reactor model. (73 references) (auth)

22357 (NP-19195) INFORMATION REGARDING THE OBTENTION OF A REACTOR FOR TRAINING AND INVESTIGATION. (Instituto de Asuntos Nucleares, Bogota (Colombia)). [nd]. 97p. Dep. NTIS (U. S. Sales Only).

A new training reactor for the Institute of Nuclear Studies is proposed. The reactor is an advanced design 10 kW, pool type, heterogeneous facility with fully-enriched plate-type uranium-aluminum fuel elements. The facility design, construction, cost, and proposed uses are presented. (H.D.R.)

22358 TRANSIENT COOLING OF A REACTOR. Slesarevskii, S. O.; Korotenko, M. N.; Nazarchuk, M. M.; Pilipets, D. T.; Stel'makh, S. S. At. Energ. (USSR); 32: No. 2, 159-60(Feb 1972). (In Russian).

The distribution of temperatures in a reactor core (reactor VVR-M) immediately after shutdown had been previously studied at different initial power levels up to 10 MW. In these tests the coolant circulation was simultaneously halted, but in no case did coolant temperature reach the boiling point. In a new series of tests the reactor core was cooled for 15 to 20 min with three pumps which delivered a total of 1,420 m^3/hr, or in another instance with one pump rated at 470 m^3/hr. The temperatures along the length of the fuel elements were measured. The abrupt temperature increases and pulsations observed are discussed. (K.S.W.)

22359 ANALYSIS OF REACTOR EXCURSIONS. Lellouche, G. S.; Shotkin, L. M. (Brookhaven National Lab., Upton, N. Y.). pp 553-68 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

A guide to the experimental reactor-excursion literature is presented. Primary emphasis is given to the important feedback mechanisms observed in the SPERT series of tests. 35 references. (auth)

22360 KEMA SUSPENSION TEST REACTOR. I. DEVELOPMENT OF A THERMAL BREEDER REACTOR IN THE NETHERLANDS. Went, J. J. (N. V. SEP, Arnhem, Netherlands). Ingenieur (Utrecht); 83: A947-50(17 Dec 1971). (In Dutch).

The importance of the development of thermal as well as fast breeders is explained. The differences are discussed related to the properties of fast and thermal neutrons as: (1) inventory of fissile material per kW installed breeding gain; (2) fast-neutron destruction of construction materials; and (3) fissile isotopes most favored in different reactor types. The results and limitations for the start-up of a large fast or thermal breeder program as well as the economic consequences are presented. (auth) (Netherlands)

22361 DEPENDENCE OF PROPAGATION PHENOMENA ON THE REACTIVITY OF A SUBCRITICAL ASSEMBLY. Leonidou, D. J. (National Technical Univ., Athens). Atomkernenergie; 19: No. 1, 11-13(Feb 1972).

The propagation of thermal neutron pulses in the graphite region between the two cores of a Double-Core Reactor was studied. By locating neutron detectors along the line of propagation, a dependence has been noted of the time interval Δt_{max}, separating the time locations of the peaks of a pulse propagating from the one core to the other, on the reactivity of the two-core system. The observed phenomenon may be related with a dependence of the "lag time," a parameter of interest in the kinetics of a symmetrical two-core system, on its reactivity. (7 references) (auth)

22362 SELF-LIMITING POWER EXCURSION CHARACTERISTICS OF LIGHT WATER REACTOR. V. DOPPLER EFFECT AND ITS INFLUENCE ON POWER TRANSIENT SHAPE. Kato, Hidemasa (Hitachi Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 19-27(Jan 1972).

The Doppler effect and its influence on the shape of the power burst are studied by analyzing the experimental data from self-limiting power excursion tests on the HTR (Hitachi Training Reactor)-P core (UO_2 ceramic fuel, water moderated, enriched to 10% in ^{235}U). Uniform temperature distribution in the fuel element has usually been assumed hitherto for evaluating the Doppler reactivity feedback during a power excursion. In the HTR experiment, however some discrepancy is found in the power transient curve between the experimental results and the calculation with uniform temperature model. It is shown that most of this discrepancy can be explained as being due to the influence of the transient variation of the non-uniform temperature distribution in the fuel element, and also to the large contribution of the surface term of the effective resonance integral. (20 references) (auth)

22363 BOILING OF WATER DURING HTR PULSE OPERATION. Inagaki, Kiyokazu; Doi, Akira; Yamamoto, Hajime; Kitaguchi, Hiroshi (Atomic Energy Research Lab., Hitachi, Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 64-6(Jan 1972).

Control and Instrumentation

22364 (ORNL-TM-3533) RELEASE AND TRANSPORT OF FISSION PRODUCTS RELEASED FROM FUEL PINS IRRADIATED TO 20,000 MWD/TON: SUMMARY REPORT OF NSPP RUN 15. Parsly, L. F.; Row, T. H.; Wantland, J. L.; Franzreb, J. K. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 37p. Dep. NTIS.

Run 15 was the second run made in the Nuclear Safety Pilot Plant using fuel that had been irradiated to 20,000 MWd/ton. The results of the experiment indicate that the fission products released from such high-burnup fuel behave the same as simulated fission products produced by "doping" unirradiated UO_2 with compounds of the fission products to be studied and releasing these by melting the UO_2. A recirculating filter system, tested during the experiment,

achieved a 40-fold reduction in the airborne iodine concentration and larger reductions in airborne cesium, cerium, and barium–lanthanum. Plate-out and gas-particulate samplers proposed for use in the LOFT facility were tested, and performance was satisfactory. 5 references. (auth)

22365 (TID–5003) SAMPLE PLOTS OF MEASUREMENTS MADE ON FUEL RODS REMOVED FROM THE NRX REACTOR, CHALK RIVER. Lillie, D. W. (Division of Research (AEC), Washington, D. C.). 14 Aug 1951. 7p. Dep. NTIS.

Declassified 19 Oct 1971.

Results are plotted showing dimensional changes of fuel rods subjected to various amounts of irradiation in the NRX pile. (auth)

22366 (TID–22913) CIRCLE REPORT IV. CONTROL OF SUBMERGED REACTOR. (Nuclear Development Associates, Inc., New York). 18 Feb 1949. Contract AT(30-1)-486. 51p. Dep. NTIS.

Declassified 5 Nov 1971.

Stability criteria and control requirements are evaluated for a submerged reactor, with and without boiling. (D.E.B.)

22367 (TID–22914) CIRCLE REPORT III. HEAT TRANSFER IN SUBMERGED REACTOR. (Nuclear Development Associates, Inc., New York). 6 Jan 1949. Contract AT(30-1)-486. 29p. Dep. NTIS.

Declassified 5 Nov 1971.

22368 NEW INSTRUMENTATION SYSTEM FOR THE UNIVERSITY OF NEW MEXICO AGN-201M REACTOR. Long, Robert L.; Bridges, Herbert (Univ. of New Mexico, Albuquerque). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 20-21(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22369 HYDROGEN GAS STUDIES IN THE WWR-S(M) RESEARCH REACTOR. Findeisen, A. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 14: No. 9, 286-9(Sep 1971). (In German).

Oxyhydrogen studies were necessary in connection with increasing the power of the WWR-S reactor from 2 up to 10 MW. It has been proved that the degasifier provided for the coolant loop is not needed even for higher power. Measuring techniques and results are presented. (7 references) (auth)

22370 ON-LINE DATA PROCESSING FOR HTR REPETITIVE-PULSE OPERATION. Inagaki, Kiyokazu; Doi, Akira; Kitaguchi, Hiroshi (Atomic Energy Research Lab., Hitachi, Japan). Nippon Genshiryoku Gakkaishi; 14: No. 2, 60-7(1972). (In Japanese).

The single-pulse operation test on the Hitachi Training Reactor (HTR) has been expanded into the repetitive-pulse operation test. On-line data processing with the HITAC-10 digital mini-computer is developed to ensure safety of repetitive-pulse operation. The peak power, the reactor period, the released energy and the maximum temperature rise of fuel pellet and fuel cladding are computed by this system in short intervals of 30 ~ 60 sec from one power burst to the next. As the sheathed thermocouple is used for the measurement of fuel center temperature, its indication is corrected by the transfer function in the form of second order time lag. (8 references) (auth)

22371 CALCULO DE LA DISTRIBUCION DE TEMPERATURAS EN EL BLINDAJE BIOLOGICO DEL REACTOR NUCLEAR DEL CENTRO NUCLEAR DE MEXICO. (Calculation of the Distribution of Temperatures in the Biological Shield of the Nuclear Reactor of the Nuclear Center of Mexico). Oropeza, Jaime Jimenez. Mexico City; Instituto Politecnico Nacional (1971). 61p.

Thesis.

The source of gamma radiation in the biological shield together with methods and data to estimate its magnitude are discussed. The neutrons generate heat by capture or inelastic collision. In these cases the energies of the resulting gamma must be determined. The neutrons can also transfer energy by elastic collision with the atoms of the shield. These aspects of neutrons in the biological shield are discussed. A semi-empirical theory is used to calculate the distribution of the temperature due to the different heat sources. The results of this theory are compared with experimental data obtained in the TRIGA MARK III reactor of the Nuclear Center of Mexico. (17 references) (tr-auth)

Operation and Economics

22372 (DOCKET-50231–111) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Order Extending Provisional Operating License Date to September 4, 1973. (Division of Reactor Licensing (AEC), Washington, D. C.). 19 Jan 1972. 2p. Dep. NTIS.

22373 (DOCKET-50231–112) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Change No. 10 Allowed. (Division of Reactor Licensing (AEC), Washington, D. C.). 28 Feb 1972. 12p. Dep. NTIS.

Revised technical specifications are presented concerning the operating limits for the irradiated fuel storage tank. (D.C.C.)

22374 (TID–5176) STATUS OF THE RESTORED NRX REACTOR. Langmuir, David B. (Division of Research (AEC), Washington, D. C.). 15 Feb 1954. 10p. Dep. NTIS.

Declassified 20 Oct 1971.

The status of the restored NRX Reactor is discussed, including power, control system, physical facilities, precautions against future emergencies, decontamination, and the start-up program. A brief outline is given of future plans for a revised control system and a new calandria. (J.S.R.)

22375 CONFERENCE ON RESEARCH AND TRAINING REACTOR UTILIZATION, COLLEGE STATION, TEXAS, FEBRUARY 22–25, 1972. Farmakes, Ruth (ed.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 1-23(1972). (CONF-720202).

Included are summaries of 30 papers on university reactor utilization and operating costs. Each paper is listed by title in NSA. (H.D.R.)

For abstracts of individual papers see: 20256–20259, 20402, 20607, 20956, 21768, 22368, 22376–22391, and 22397–22401.

22376 RESEARCH REACTORS 1942–1972. Binford, F. T. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 1-2(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22377 CHANGING TRENDS IN UTILIZATION OF THE MIT RESEARCH REACTOR. Lanning, David D. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 2-3(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22378 BIOMEDICAL APPLICATIONS OF RESEARCH REACTORS. Hightower, Dan; Kyzar, J. R.; Wright, E. M. (Texas A and M Univ., College Station). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 7(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22379 WHAT CAN YOU DO WITH A UNIVERSITY REACTOR? THE GEORGIA TECH STORY. Apple, F. C.; Kirkland, R. S.; McLain, M. E.; Leddicotte, G. W. (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 9(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22380 OPERATING COSTS: THE BASIS FOR REACTOR RENTAL CHARGES. Clark, L. Jr.; Cochrane, J. L. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 9-10(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22381 IMPLEMENTATION OF THE USAEC REACTOR SHARING PROGRAM AT TEXAS A AND M UNIVERSITY. Anderson, Donald G.; Randall, John D. (Texas A and M Univ., College Station). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 11(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22382 OPERATION AND UTILIZATION OF THE RHODE ISLAND NUCLEAR SCIENCE CENTER REACTOR FACILITY. DiMeglio, A. Francis; Doyle, Michael P. (Rhode Island Nuclear Science Center, Narragansett). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 11(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22383 PROFILE FOR THE ECONOMIC SUCCESS OF UNIVERSITY-TYPE RESEARCH REACTORS. Bohannon, James R. Jr. (North Carolina State Univ., Raleigh). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 11-12(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22384 SURVEY OF TRAINING REACTOR FACILITY UTILIZATION. Long, Robert L. (Univ. of New Mexico, Albuquerque). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 18(1972).

From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22385 EDUCATIONAL USES OF THE UNIVERSITY OF MISSOURI-ROLLA REACTOR. Edwards, D. Ray; Bolon, Albert

E.; Elliott, Alva E. (Univ. of Missouri, Rolla). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 19(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22386 UTILIZATION OF SMALL TRAINING REACTORS IN THE USAEC'S OVERSEAS NUCLEAR SCIENCE DEMONSTRATION CENTERS. Bradburne, John C. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 19(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22387 TEXAS A AND M UNIVERSITY TRAINING REACTOR. Smathers, J. B.; Cochran, R. G.; Randall, J. D. (Texas A and M Univ., College Station). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 21(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22388 UNDERGRADUATE EDUCATION AND VOCATIONAL TRAINING AT THE BREAZEALE NUCLEAR REACTOR. Penkala, J. L.; Geisler, G. C. (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 21-2(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22389 SCOTTISH RESEARCH REACTOR CENTER. Wilson, H. W. (Scottish Research Reactor Center, East Kilbride, Scotland). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 22(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22390 NEW ASPECTS IN THE UTILIZATION OF AN ARGONAUT-TYPE REACTOR. Diaz, N. J.; Ohanian, M. J. (Univ. of Florida, Gainesville). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 22(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22391 UTILIZATION OF A LOWER POWER REACTOR AS A MULTIPURPOSE FACILITY. Wilbur, L. C. (Worcester Polytechnic Inst., Mass.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 22-3(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

Safety and Siting

Refer also to abstracts 20256, 20257, 20956, and 21768.

22392 (GEMP-159) HAZARD SUMMARY REPORT FOR THE 710 FAST-SPECTRUM REACTOR CRITICAL EXPERIMENT. (General Electric Co., Cincinnati, Ohio. Flight Propulsion Lab. Dept.). 27 Nov 1962. Contract AT(40-1)-2847. 143p. Dep. NTIS.
Includes Addendum 1 and 5.
A description of the critical experiment using a nuclear mockup of the 710 Fast Spectrum Refractory Metal Reactor at the Low Power Test Facility at the National Reactor Testing Station is presented. The radiological hazards conceivably resulting from an accidental power excursion are discussed, and it is concluded that, while such an event is improbable, the resultant hazards do not constitute an unacceptable risk. (52 references) (auth)

22393 (RDT-E-8-11-T(12-71)) FFTF CLOSED LOOP IN-REACTOR ASSEMBLY FABRICATION. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Dec 1971. 23p. RSO.
The Closed Loop In-Reactor Assembly (CLIRA) is the in-reactor component of the Closed Loop System for irradiation of fuels and materials test assemblies. It provides physical support for, distributes coolant supply to, and provides process and test section instrumentation leads, tubes and sensors. It isolates the experiments from the reactor sodium pool and prevents test failure propagation to the reactor. The requirements for the fabrication, quality assurance, packaging, and delivery of the CLIRA are presented. All components and services to be provided by the supplier are specified. (auth)

22394 (TID-11892) NATURAL CONVECTION IN-PILE LOOP. Sparrell, J. K. (Pratt and Whitney Aircraft, Middletown, Conn.). 27 Dec 1957. Contract AT(11-1)-229. 27p. (FXM-3427). Dep. NTIS.
Declassified 20 Oct 1971.
An in-pile loop design for the Engineering Test Reactor is presented. The loop would serve for testing fuel pins in natural convection NaK coolant flow. (H.D.R.)

22395 (TID-25934) FINAL SOIL INVESTIGATION REPORT FOR THE FAST FLUX TEST FACILITY, RICHLAND, WASHINGTON. (Bechtel Corp., San Francisco, Calif.). Oct 1971. 195p. Dep. NTIS.
For WADCO Corp., Richland, Wash.
A soil investigation was made to develop foundation design criteria for structures of the Fast Flux Test Facility. The investigation consisted of drilling 9 holes at locations of structures, making standard penetration tests, obtaining undisturbed soil samples from the drill holes, laboratory testing, analyzing the data obtained and developing foundation design criteria. An extensive laboratory soil testing program was carried out. This included controlled stress cyclic triaxial tests for liquefaction, potential evaluation of the site sands, and controlled strain cyclic triaxial tests to determine the variation of the elastic moduli of the site soils at different strain levels in response to a request from the Division of Reactor Licensing of the Atomic Energy Commision. Results of the tests are presented. (auth)

22396 FAST NEUTRON FLUX DETERMINATIONS IN EXPERIMENTAL HOLES OF THE MR REACTOR. Borodin, A. V.; Vikhrov, V. I.; Krasnoshtanov, V. F.; Perevezentsev, V. N.; Shatalov, G. E. At. Energ. (USSR); 32: No. 2, 161(Feb 1972). (In Russian).
Neutron fluxes were determined at energies ranging from 1.7 to 7.2 MeV in certain experimental holes in the MR reactor. Threshold reactions utilized were neutron activations of the following isotopes: ^{115}In, ^{54}Fe, ^{46}Ti, ^{24}Mg, and ^{27}Al. (K.S.W.)

22397 HIGH FLUX TEST FACILITY IN A 2-MW RESEARCH REACTOR CORE. Kok, Kenneth D. (Battelle Columbus Labs., Columbus, Ohio). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 3(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22398 SYSTEM FOR REDUCTION OF ^{41}A RELEASE FROM A RESEARCH REACTOR FACILITY. Davidson, John; Gage, S. J.; Draper, E. Linn Jr.; Bouchey, G. D. (Univ. of Texas, Austin). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 4-5(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22399 D_2O THERMAL COLUMN AT THE BREAZEALE NUCLEAR REACTOR. Geisler, G. C.; Levine, S. H.; McMaster, I. B. (Pennsylvania State Univ., University Park). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 5-6(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22400 VERTICAL NEUTRON BEAM PORT FOR THE UNIVERSITY OF VIRGINIA REACTOR. Graf, J. M.; Johnson, W. R. (Univ. of Virginia, Charlottesville). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 6-7(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

22401 NEUTRON AND X-RAY RADIOGRAPHY SERVICE FACILITIES AT THE UNIVERSITY OF MISSOURI. Harrison, Thomas G.; Alger, Donald M.; Vogt, James R. (Univ. of Missouri, Columbia). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 1, 13-14(1972).
From Conference on research and training reactor utilization; College Station, Tex. (22 Feb 1972).

Reactor Components, Fuels, and Accessories

Refer also to abstracts 19986, 20226, 20682, 20698, 20701, 20728-20732, 20745, 20746, 20752, 20791, 20891, 20936, and 20950.

22402 (RDT-C-8-6-T) HYDROGEN METER FOR SERVICE IN LIQUID SODIUM. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 30p. RSO.
The requirements are established for the design, materials, fabrication, quality assurance, examination, and acceptance testing of a hydrogen meter and auxiliary equipment for use in radioactive or nonradioactive liquid sodium service. The meter shall provide a continuous and accurate indication of the hydrogen impurity concentration over the range 0.03 to 10 ppM hydrogen in sodium at temperatures between 800 and 1000°F. The meter may also be used to rapidly monitor changes in hydrogen concentration, over the same concentration range, and, therefore, be used as a sensor for sodium-water reactions in LMFBR steam generators. (auth)

22403 (RDT-C-8-7-T) DIFFUSION CARBON METER FOR SERVICE IN LIQUID SODIUM. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 28p. RSO.

The requirements are established for the design, materials, fabrication, quality assurance, examination, and acceptance testing of a diffusion carbon meter and auxiliary equipment for service in radioactive and nonradioactive liquid sodium. The meter provides a continuous indication of the carbon level and changes in carbon level, through its range of sensitivity, to the chemical activity of carbon in sodium. (auth)

22404 (RDT-C-8-8-T) SPECIMEN EQUILIBRATION DEVICE FOR THE ANALYSIS OF NONMETALS IN LIQUID SODIUM. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 26p. RSO.

The requirements are established for the design, materials, fabrication, quality assurance, examination, and acceptance testing of an equilibration device and auxiliary equipment for service in radioactive or nonradioactive liquid sodium. The device can be used alone as a step in the analysis for nonmetallic impurities in sodium, or it can be used, for calibration, in parallel with meters monitoring the activities in sodium of oxygen, hydrogen, and carbon. (auth)

22405 (RDT-E-6-13-T(1-72)) CORE SUPPORT STRUCTURE FOR SODIUM COOLED REACTORS (FABRICATION ONLY). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 22p. RSO.

The core support structure provides support, location and flow distribution for the fuel assemblies, reflector and radial shield. It also provides support for interfacing hardware items. The requirements are presented for the fabrication, quality assurance, packaging and delivery of the core support structure. (auth)

22406 (RDT-E-6-23-T(12-71)) CORE RADIAL SHIELD FOR SODIUM COOLED REACTORS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Dec 1971. 20p. RSO.

The requirements are presented for the fabrication, quality assurance, packaging and delivery of core radial shieldings. The ordering data establishes the specific requirements for a particular radial shield. The purpose of the radial shield is to limit the total dose of damaging radiation on critical in-vessel components to assure acceptable end-of-life properties. The standard applies to a radial shield for use in a liquid metal cooled reactor vessel. (auth)

22407 (RDT-E-6-25-T(11-71)) CONTROL ROD ABSORBER PIN. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Nov 1971. 15p. RSO.

The requirements for absorber pins for nuclear reactor control rod assemblies are presented. (auth)

22408 (RDT-E-6-30-T(8-71)) ABSORBER PIN BORON CARBIDE PELLET. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1971. 12p. RSO.

The requirements for boron carbide pellets to be used in nuclear reactor control rod absorber pins are presented. (auth)

22409 (RDT-C-8-5-T) ELECTROCHEMICAL OXYGEN METER FOR SERVICE IN LIQUID SODIUM. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 39p. RSO.

The requirements are established for the design, materials, fabrication, quality assurance, examination, and acceptance testing of an electrochemical oxygen meter and auxiliary equipment for use in radioactive or nonradioactive liquid sodium service. The meter shall provide a continuous indication of the oxygen impurity concentration over the range 0.5 to 20 ppM oxygen in sodium at temperatures between 700 and 800°F. Operation at higher temperatures results in reduced lifetimes of the electrochemical cell. (auth)

22410 (RDT-E-8-13T) OXYGEN-HYDROGEN METER MODULE FOR SERVICE IN LIQUID SODIUM. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 29p. RSO.

The requirements are established for the design, materials, fabrication, quality assurance, examination, and acceptance testing of an Oxygen-Hydrogen Meter Module (O-H Module) for use in monitoring oxygen and/or hydrogen impurities in radioactive or nonradioactive sodium. The O-H Module includes one or two electrochemical oxygen meters and/or one hydrogen activity meter and the required sodium flow and temperature control accessories for operation of the meters. The Module will provide for proper operation of the oxygen and hydrogen meters for sodium sample temperatures from 400 to 1200°F at a sodium flow rate of 0.25 gpm. (auth)

22411 (RDT-E-8-14-T) CARBON METER-EQUILIBRATION MODULE FOR SERVICE IN LIQUID SODIUM. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 29p. RSO.

The requirements are established for the design, materials, fabrication, quality assurance, examination, and acceptance testing of a carbon meter-specimen equilibration module (C-E Module) for use in (a) monitoring the chemical activity of carbon dissolved in radioactive or nonradioactive sodium, or (b) for calibrating meters that monitor the activities of nonmetallic impurities (O, H, C, N) in radioactive or nonradioactive sodium by establishing in metal specimens contents of these impurities that are in equilibrium with their activities in the sodium. The module includes one carbon meter or one equilibration device; it provides for proper operation of the meter or device for sodium sample temperatures in the range 400-1200°F, at a sodium flow rate of 0.1 gpm. (auth)

22412 APPLIED MECHANICS ASPECTS OF NUCLEAR EFFECTS IN MATERIALS. Winter Annual Meeting of the American Society of Mechanical Engineers, Washington, D. C., December 2, 1971. Wan, Conrad C. (ed.). New York; American Society of Mechanical Engineers (1971). 208p. $20.00. (CONF-711206).

Included are 7 papers on the behavior of materials subjected to nuclear effects. A separate abstract was prepared for each of the papers. (H.D.R.)

For abstracts of individual papers see: 20246-20249, 22198, 22413, and 22414.

22413 TRANSIENT THERMAL STRESS TECHNIQUES IN NUCLEAR REACTORS. Hsu, Tai-ran (Univ. of Manitoba, Winnipeg). pp 1-65 of Applied Mechanics Aspects of Nuclear Effects in Materials. /Wan, Conrad C. (ed.). New York; American Society of Mechanical Engineers (1971).

From Meeting on applied mechanics aspects of nuclear effects in materials; Washington, D. C. (2 Dec 1971).

Several techniques are presented for the solutions of transient thermoelastic problems associated with nuclear reactors. Integral transform techniques of various forms were used in the heat transfer analysis and tables are provided for the solutions. Thermoelastic displacement potential functions were used effectively for the solutions of thermal stresses. A numerical method, such as a finite element method, is recommended for the components of irregular geometries and temperature-dependent material properties. A special topic is given on the reliability analysis of the "nuclear refractory" materials. The potential applications of such materials in future high temperature nuclear reactor constructions are recognized. Extensive numerical illustrations are included. These examples are pertinent to the actual nuclear reactor component design. 40 references. (auth)

22414 TEMPERATURE EFFECTS IN ELASTIC AND PLASTIC WAVE PROPAGATION. Lindholm, Ulric S.; Francis, Philip H. (Southwest Research Inst., San Antonio). pp 76-104 of Applied Mechanics Aspects of Nuclear Effects in Materials. /Wan, Conrad C. (ed.). New York; American Society of Mechanical Engineers (1971).

From Meeting on applied mechanics aspects of nuclear effects in materials; Washington, D. C. (2 Dec 1971).

The generation of elastic and plastic waves by thermal and/or mechanical disturbances is a problem area of concern to the nuclear and other technologies. A review is given of some of the more significant work accomplished regarding elastic and plastic wave propagation where thermomechanical interactions are important. The problems discussed include the effects of thermoelastic coupling and the influence of temperature dependent elastic and plastic properties on dynamic response. An important overall fact that emerges is lack of experimental work, which is needed to place the theory on a firmer basis and to evaluate the practical significance of the theoretical results in terms of material integrity. 81 references. (auth)

22415 NUCLEAR CONTAINMENT VESSELS. Sweeney, E. A. (to Stone and Webster Engineering Corp.). British Patent 1,254,813. 24 Nov 1971. Priority date 10 Jun 1969, United States.

REACTOR CONTAINMENT STRUCTURES—design characteristics of reinforced concrete (D.C.C.)

22416 METALLIC INTERNAL LINING FOR PRESTRESSED-CONCRETE PRESSURE CONTAINERS. (to Fried Krupp Gesellschaft Mit Beschrankter Haftung). British Patent 1,255,000. 24 Nov 1971. Priority date 5 Nov 1969, Germany.

PRESSURE VESSELS—liner for prestressed concrete, design characteristics of thermal insulated metal

REACTORS—pressure vessels for, design characteristics of thermal insulated metal liner for prestressed concrete

THERMAL INSULATION—design characteristics of liner, for prestressed concrete pressure vessels (D.C.C.)

22417 IMPROVEMENTS RELATING TO SAFETY DEVICES FOR NUCLEAR REACTORS. Dean, John Raymond; Wilcox, William Henry Graham (to A. Reyrolle and Co. Ltd.). British Patent 1,262,974. 9 Feb 1972. Filed 2 Apr 1969.

Reference is made to control rod operation in reactors having vertical rods suspended in the reactor pressure vessel from a superstructure. In the system described the control rods operate automatically in response to a relative displacement, in excess of a predetermined amount, between the pressure vessel and the superstructure from which the control rods are suspended, such a displacement releasing the rods. The system is designed for operation in the event of an earthquake, an explosion in the vicinity of the reactor, or structural faults developing in the reactor. The control rod is supported by a support member which is releasably secured by latch means to an elongated suspension member. The latch is released in response to a tilting movement, of predetermined minimum angular extent and in any direction, of the suspension member relative to the control rod support member about a transverse tilting axis through the latch. The latch is provided with an elongated release plunger, held in alignment with the suspension member for tilting therewith, and movable longitudinally against biassing means to release the latch. The suspension member and the control rod support member may be telescoped and latched together against separation by a ball latch arrangement. The interconnection for moving the release plunger to its release position may be a camming arrangement. Means are incorporated for adjusting the minimum angle of tilt that will cause release of the latch. (UK)

22418 CONCRETE CONTAINMENTS FOR REACTORS: STATE OF ART. Tan, C. P. J. Struct. Div., Amer. Soc. Civil Eng.; 96: ST-7, 1543-66(Jul 1970).

A summary of some of the methods used in the design and construction of concrete containment vessels for nuclear reactors is presented. Prestressed and reinforced concrete vessels are compared. A general discussion is given for design, methods of analysis, earthquake resistant design, leak-tightness, concrete, reinforcing and prestressing steel, tornado resistance design, missile generation and protection, quality assurance, methods of construction, and performance tests. (51 references) (App. Mech. Rev.)

Reactor Physics and Core Engineering

Physics

Refer also to abstract 22225.

22419 (CEA-R-4243) MEASUREMENT OF THE PULSE RESPONSE OF A NUCLEAR REACTOR BY PSEUDO RANDOM EXCITATION. Froelicher, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov 1971. 127p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Grenoble Univ. (France). Faculte des Sciences.

The pulse response of a subcritical nuclear reactor was investigated. The reactor was excited by a pseudo random modulated neutron generator using a shifting register. The output signal was provided by neutron detectors. The intercorrelation functions between the exciting signal and the signals from the detectors and the autocorrelation functions of the detectors were calculated. The pulse response of the reactor, considered as an exponential decay, was compared with the correlation functions. The different sources of error were established. This was accomplished by predetermining: the effect of sampling on the form of the power density spectra; the effect of quantization on the accuracy of the correlation functions; the effect of the finite time of observation on the variance in the estimation of the correlation function and, using the Fourier transformation, on the accuracy attainable in the power density spectra. An attempt was made to determine to what extent excitation faults can be eliminated using a deconvolution operation. Experimental difficulties were largely overcome in the following stages: construction and control of the electronics of the detection unit; classical experiment serving as a reference; presentation of the numerical data; and computer handling. 105 references. (auth)

22420 (JAERI-1215) ONE-DIMENSIONAL, MULTIGROUP, NEUTRON DIFFUSION THEORY CODE. Ise, Takeji; Kubo, Atsuhiro (Japan Atomic Energy Research Inst., Tokyo). Sep 1971. 23p. (In Japanese). NTIS (U. S. Sales Only).

GURNET is a multigroup diffusion theory code for one-dimensional reactor analysis. Main features of the code are: calculational capability in all four types of the standard geometries of slab, sphere, cylinder, axial cylinder; scattering-transfer of neutrons allowed between all groups; calculational capability of adjoint as well as normal flux; energy-dependent albedo-type boundary conditions at the inner and outer boundaries; optional use of macroscopic cross sections or microscopic cross sections; capability of reading input flux guess and of punching the output fluxes for subsequent input to GURNET; material-dependence of the fission spectrum; and convenient input form for users familiar with AIM-6 and FOG. CDC (3600, 6600) versions are available. (auth) (Japan)

22421 (TID-19478) W-UO_2 FAST REACTORS. Kirk, W. L. (Los Alamos Scientific Lab., N. Mex.). 30 Oct 1959. Contract W-7405-eng-36. 11p. Dep. NTIS.

Declassified 21 Oct 1971.

The results of this study indicate that fast W-UO_2 systems are likely to be useful only if fuel loadings near 40 or 50 v/o can be obtained. Even with these loadings, such systems do not compare very favorably with carbide reactors on the basis of idealized performance characteristics. However, it may turn out that the fabricability and mechanical and physical properties of tungsten-base fuel elements are sufficiently superior to those of the carbides to completely overcome the theoretical superiority of the carbide reactors. (auth)

22422 (TID-22915) CIRCLE REPORT II. PILE SIZES AND FUEL REQUIREMENTS. (Nuclear Development Associates, Inc., New York). 7 Jan 1949. Contract AT(30-1)-486. 14p. Dep. NTIS.

Declassified 5 Nov 1971.

22423 PIMFUX: A 3 DIMENSIONAL MODEL FOR SIMULATION OF REACTIVITY DISTURBANCE. Schmidt, A. (Technische Univ., Munich). Atomwirt., Atomtech.; 17: No. 2, 82-3 (Feb 1972). (In German).

PIMFUX is a three-dimensional computer program for solving the unsteady two-group diffusion equations in Cartesian coordinates. An arbitrary number of delayed neutron energy groups may be employed. An example of a computation is outlined with given reactor dimensions and travel speed of a control rod, assuming a ¼-symmetry. The course of average and maximum thermal flux during the resulting excursion is then computed. (K.S.W.)

22424 ANALYSIS OF STOCHASTIC PROCESSES IN POWER REACTORS. Hennig, D. (VEB Kombinat Kraftwerksanlagenbau, Berlin). Kernenergie; 14: No. 12, 378-84(Dec 1971). (In German).

Because of the stochastic nature of the processes, the variables of steady-state dynamic systems are subjected to small random fluctuations. On the basis of an analysis of those stochastic processes, methods for determining characteristic values (e.g., the temperature coefficients) may be developed. The spectral power densities of the random output processes of a reactor with two temperature coefficients are calculated in the Markoff approximation (i.e., the processes are considered as steady-state Markoff processes). (11 references) (auth)

22425 DYNAMICS OF NUCLEAR SYSTEMS. Nuclear Engineering Symposium, Tucson, Arizona, March 23-25, 1970. Hetrick, David L. (ed.). Tucson, Ariz.; University of Arizona Press (1972). 614p. $14.50. (CONF-700304).

Included are 33 papers on the dynamic response characteristics of nuclear reactors. A separate abstract was prepared for each of 28 papers. Five papers were previously abstracted for NSA and may be located under CONF-700304 in the Report Number Index. (H.D.R.)

For abstracts of individual papers see: 22186, 22209-22211, 22359, and 22426-22448.

22426 REVIEW OF COMPUTATIONAL METHODS FOR SPACE-DEPENDENT KINETICS. Henry, A. F. (Massachusetts Inst. of Tech., Cambridge). pp 9-21 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

22427 INDUSTRIAL REQUIREMENTS IN REACTOR TRANSIENT ANALYSIS. Gyorey, Geza L. (General Electric Co., Sunnyvale, Calif.). pp 23-7 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

The status of reactor transient analysis from the point of view of a user of calculational tools in an industrial environment is examined. The characteristics and qualities of calculational tools that make them useful in applied work are discussed. (H.D.R.)

22428 SPACE- AND FREQUENCY-DEPENDENT ENERGY SPECTRUM OF NEUTRON WAVES IN A MODERATING MEDIUM. Booth, R. S.; Swansiger, W. A. (Oak Ridge National Lab., Tenn.). pp 29-47 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

The energy spectrum of neutron waves is reconstructed with both frequency and position as parameters. The reconstructed flux is compared to the complex energy eigenfunction associated with the discrete, complex inverse relaxation length to determine if this discrete energy mode dominates the spectrum. (H.D.R.)

22429 NEUTRON-WAVE ANALYSIS IN FAST-MULTIPLYING MEDIA. Travelli, A. (Argonne National Lab., Ill.). pp 49-63 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

A method was developed for the analysis of neutron waves in fast-multiplying media, taking into account delayed multiplication and the ultrafine energy dependence of the cross sections. The method was tested successfully in a particular case. (8 references) (H.D.R.)

22430 SOME RECENT APPLICATIONS OF A MODULATED SOURCE. Nelson, G. W.; Brehm, R. L.; Seale, R. L. (Univ. of Arizona, Tucson). pp 65-85 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

Applications of pulsed and internally modulated experiments for the determination of particle interaction parameters are described. The experiments include internally modulated source thermal mode studies and pulsed source determinations of thermal neutron lifetimes in moderators with internal voids. (H.D.R.)

22431 REACTOR DYNAMICS STUDIES IN LARGE CLOSE-TO-CRITICAL SYSTEMS. Diaz, N. J.; Ohanian, M. J. (Univ. of Florida, Gainesville). pp 87-108 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

The dynamic behavior of a slightly subcritical ($k_{eff} \simeq 0.99$), large-in-one-dimension, light-water moderated and reflected assembly using 4.8 percent enriched UO_2 fuel rods was determined experimentally after excitation by an external neutron source. Pulse-propagation characteristics and related parameters were obtained for three different metal-to-water ratios (.5, 1, and 1.5), and intercomparisons between the WIGLE calculational scheme and the experimental data were made. The intercomparisons show that the WIGLE calculational scheme gives non-conservative results for the propagation characteristics of a neutronic disturbance. (15 references) (auth)

22432 CONSISTENT SUBCRITICAL FAST-REACTOR KINETICS. Gonzani, T. (Gulf Energy and Environmental Systems, Inc., San Diego, Calif.). pp 109-39 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

The general effects of the kinetic distortion on measured reactivity are discussed. Emphasis is on the implications of the theoretical results to kinetic techniques of reactivity measurement in fast systems. Also included are the effects of neutron detectors on measurements and a technique for reduction of kinetic distortion. (26 references) (H.D.R.)

22433 PROMPT NEUTRON-DECAY CONSTANTS IN A REFLECTED FAST BURST REACTOR. Long, Robert L.; Price, Charles C. (Univ. of New Mexico, Albuquerque). pp 141-63 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

Reactivity perturbation effects caused by the addition of reflectors to a fast reactor were studied. The prompt neutron decay constants as a function of reactivity were measured over a range of one dollar subdelayed critical to one dollar and ten cents superdelayed critical. The data obtained were used with a nodal point-kinetics model for a reflected fast burst reactor. (H.D.R.)

22434 FINITE-DIFFERENCE SOLUTIONS FOR SPACE-DEPENDENT KINETICS EQUATIONS. Hansen, K. F. (Massachusetts Inst. of Tech., Cambridge). pp 165-75 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

22435 FORMULATION OF TIME-DEPENDENT MULTICHANNEL SYNTHESIS EQUATIONS. Becker, M.; Finch, D. R.; Stewart II, J. W. (Savannah River Lab., Aiken, S. C.). pp 177-87 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

The formulation of time-dependent multichannel synthesis equations is reviewed. A common physical assumption is avoided, the variational formulation is decoupled from the numerical analysis, and the equations are expressed in a computationally convenient form. Computational requirements associated with inclusion of a detailed feedback treatment are satisfied. (12 references) (auth)

22436 COUPLED-REGION KINETICS FORMULATIONS. Harris, D. R.; Fluharty, R. G. (Los Alamos Scientific Lab., N. Mex.). pp 189-209 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

Coupled-region kinetics is a synthesis technique of particular interest in the design of nuclear systems for which particular flight times within and between regions are not negligible. We obtain an exact and general reformulation of coupled-region kinetics by integrating the Boltzmann equation over phase space regions, applying the divergence theorem to the gradient terms to obtain integrals over surfaces of regions, and then evaluating these surface integrals by application of the integral transport equation with free-flight kernel. The structure and numerical solution of the resulting coupled-region-kinetics equations are examined in terms of examples, including a pulsed multiplier in a cavity. (49 references) (auth)

22437 NEW CALCULATIONAL TECHNIQUE FOR SPACE-ENERGY-ANGLE-DEPENDENT REACTOR KINETICS. Dodds, H. L. Jr.; Robinson, J. C. (Univ. of Tennessee, Knoxville). pp 211-32 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

A calculational technique for solving zero-power reactor kinetic equations in the frequency domain was developed. The algorithm can be applied to either one-dimensional, multigroup diffusion theory or to the discrete-ordinates approximation to one-dimensional transport theory. The technique developed is based on a combined transfer-scattering (or response) matrix approach that includes spatially distributed, external sources. Calculated results agreed well with experimental results for a one-region-slab subcritical assembly. Results for a two region slab (core reflector) were also calculated. (12 references) (auth)

22438 SOME NONLINEAR PROBLEMS IN SPACE–TIME KINETICS. Canosa, Jose (IBM Scientific Center, Palo Alto, Calif.). pp 233-47 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

A discussion is presented of some space-dependent nonlinear problems suggested by reactor excursions and other time-dependent problems of interest in reactor theory. A combination of analytic and numerical techniques is used to reveal certain basic features common to several nonlinear problems of this kind. (11 references) (auth)

22439 SOME ASPECTS OF STABILITY AND CONTROL OF DISTRIBUTED PARAMETER NUCLEAR REACTOR SYSTEMS. Kastenberg, William E.; Ziskind, Richard (Univ. of California, Los Angeles). pp 249-63 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

Stability theory for distributed parameter systems is applied to reactor models in which spatial effects caused by local regions of positive feedback create problems. (27 references) (H.D.R.)

22440 SOME PITFALLS IN REACTOR KINETICS CALCULATIONS. Mortensen, G. A.; Putnam, G. E. (Idaho Nuclear Corp., Idaho Falls). pp 277-85 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

22441 STABILITY DOMAINS FOR LINEARLY STABLE SYSTEMS. Hetrick, David L. (Univ. of Arizona, Tucson). pp 287-309 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

Aspects of nonlinear stability of the point-reactor model with various types of linear reactivity feedback models are discussed. Particular attention is given to cases in which the net reactivity following a sudden power perturbation may be positive for a time. (19 references) (H.D.R.)

22442 CORRELATION OF POWER EXCURSION AND CORE DESIGN CHARACTERISTICS OF NUCLEAR REACTORS. Green, Michael D.; Gyftopoulos, Elias P. (Massachusetts Inst. of Tech., Cambridge). pp 383-404 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

A methodology based upon dimensional analysis is presented for the derivation of correlations between reactor excursion characteristics, such as the maximum power, and core design characteristics, such as the void coefficient of reactivity. The methodology may be used: (a) to correlate available excursion data, and (b) to obtain correlations by means of only a few computer calculations. (19 references) (auth)

22443 UNLIMITED POWER EXCURSIONS IN NUCLEAR REACTORS. Smets, Henri B. (Univ., Liege). pp 405-28 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

The transient behavior of reactor systems with unbounded power excursions over a finite time interval is studied. The transient behavior of the adiabatic model with a positive temperature coefficient is considered, and a criterion of instability for the general case is derived. The study is restricted to situations in which the reactor is prompt critical and is initially at low power. (H.D.R.)

22444 FAST AND THERMAL REACTOR PROMPT KINETICS VIA MODELS. Dorning, J. (Brookhaven National Lab., Upton, N. Y.). pp 429-52 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

The formalism for the response of a fast reactor to a burst of neutrons is reviewed. Applications of this formalism to other experiments and phenomena related to the dynamics of nuclear systems are discussed. Some analytical techniques and models used are reviewed and illustrated. The relationship of the theoretical results (obtained for models) to experimental measurements is discussed. Some recent progress and examples along the lines of the earlier analyses are also presented. Finally, reflected fast systems are briefly discussed. (35 references) (auth)

22445 SPECTRAL SYNTHESIS METHODS IN FAST-REACTOR DYNAMICS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). pp 453-66 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

The mathematical formulation of the spectral synthesis method, in which the lethargy dependence of the neutron flux and current are expanded in known functions of lethargy which may vary in space and time, is developed for the P_1 representation of the reactor dynamics equations. Results of a simulated sodium voiding transient, with Doppler feedback, indicate that the spectral synthesis method may be significantly more accurate than few-group methods of comparable computational complexity for fast-reactor dynamics calculations. (10 references) (auth)

22446 KINETICS MODEL FOR FAST REACTOR ANALYSIS IN TWO DIMENSIONS. Menely, D. A.; Leaf, G. K.; Lindeman, A. J.; Daly, T. A.; Sha, W. T. (Argonne National Lab., Ill.). pp 483-500 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

A two-dimensional multigroup kinetics algorithm based on a flux factorization technique was developed for use in LMFBR safety calculations. The model is based on the quasistatic method. The algorithm is capable of accounting for large fuel displacements in core meltdown and disassembly problems. (19 references) (H.D.R.)

22447 COMPACTION OF A ZONED-ENRICHMENT FAST REACTOR. Rhoades, W. A. (North American Rockwell Corp., Canoga Park, Calif.). pp 501-8 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

Using a model deliberately chosen to yield a large positive reactivity effect due to compaction of a nonfuel center zone, it was possible to produce a large secondary criticality event initiated by a small input of reactivity. Filling the zone with a less-compressible material prevented the event. Using a model that gives constant vertical leakage from the zone, whether compacted or not, likewise prevented the event. No secondary criticality was found in the base two-enrichment-zone FBR model. (auth)

22448 EVALUATION OF FUEL FEEDBACK DELAYS IN REACTOR DYNAMICS. Koehler, W. H. (Texas A and M Univ., College Station). pp 569-84 of Dynamics of Nuclear Systems. /Hetrick, David L. (ed). Tucson, Ariz.; Univ. of Arizona Press (1972).

From Symposium on dynamics of nuclear systems; Tucson, Ariz. (23 Mar 1970).

The calculation of various fuel reactivity feedback delay times, such as heat-transfer delay time, slowing-down delay time, and expansion delay time, is discussed. Simple dynamics models are discussed to obtain analytical expressions for effects of the delay times on energy or temperature increase in superprompt-critical excursions. Some comparisons with more refined models are made. (21 references) (auth)

22449 EFFECT OF ANISOTROPIC SCATTERING IN A SQUARE CELL WITH THIN MODERATOR. Takeda, Toshikazu; Nakamura, Kazuhiro; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 1, 53-4(Jan 1972).

22450 BURN-UP DETERMINATION OF IRRADIATED FUELS BY MEANS OF THEIR HEAT OUTPUT. BASIC RELATIONS AND MEASUREMENTS OF HIGHLY ENRICHED URANIUM AT A VERY LOW BURN-UP LEVEL. Ramthun, H.; Debertin, K. (Physikalisch-Technische Bundesanstalt, Brunswick). Atomkernenergie; 19: No. 1, 17-22(Feb 1972).

The relation between the heat output of an irradiated fuel specimen and the corresponding relative burnup value is discussed. Computations of heat power values for different irradiation histories but the same burnup demonstrate that the knowledge of the reactor operating periods usually on hand may be sufficient to infer the actual burnup from a measured heat power. An adiabatic calorimeter with suitable dimensions and sensitivity for the available sections of MTR fuel elements has been constructed and a specimen of low burnup has been measured. By aid of a computer program taking into account more than 40 fission nuclides a burnup value has been evaluated which agrees with the result of a γ-spectroscopic determination within the measurement uncertainty. (13 references) (auth)

22451 NEW METHOD FOR THE MEASUREMENT OF REACTIVITY IN ABSOLUTE UNITS AND FOR THE EXPERIMENTAL DETERMINATION OF THE EXCESS REACTIVITY (THE METHOD OF STATISTICAL WEIGHTS). Mogilner, A. I. (Inst. for Physics and Energetics, Obninsk, USSR); Szatmary, Z.; Kosaly, G. Atomkernenergie; 19: No. 1, 1-10(Feb 1972).

The concept of the statistical weight of the reactor S is introduced and possible applications of the concept are discussed. The relation between S and another new quantity k^+ opens the way to the experimental determination of reactivity in absolute units, and to the measurement of the excess reactivity of power reactors. The applicability of the method is illustrated by numerical examples. (11 references) (auth)

22452 STABILITY OF COUPLED-CORE NUCLEAR REACTORS. Noldus, E. (Univ., Ghent). J. Eng. Math.; 6: No. 1, 31-5(Jan 1972).

A Liapunov functional is proposed for the stability analysis of coupled-core nuclear reactors. Subsequently a set of stability criteria and stability regions in function space are determined. The method is better than those relying on the use of ordinary Liapunov functions. (4 references) (auth)

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Refer also to abstract 20962.

22453 (LA–4824, pp 175–80) DESIGN: AN NPL PROGRAM FOR DATA ACQUISITION AND REDUCTION. Bevington, Philip R. (Case-Western Reserve Univ., Cleveland, Ohio). Nov 1971.

From LAMPF Summer study session; Los Alamos, N. Mex. (9 Aug 1971).

DESIGN (Data Evaluation, Storage, Inspection, and Graphing for Nucleon Physics) is a system of computer subroutines developed to acquire, reduce, and display data on-line from nucleon physics experiments. The routines construct a multiparameter histogram of up to 262,144 words on a disk. The routines are written in PAL-11 code, compatible with FORTRAN main programs, for use on a PDP-11 computer equipped with at least 16K words of memory, hardware multiply/divide arithmetic, 256K words of spare disk storage, industry-compatible magnetic tape, Tektronix 611 storage oscilloscope, light pen, and CAMAC interface. A specialized IDIOT (Indicating Digitizer for Input/Output Transformations) panel is required in addition for manual control of the display and experiment. The routines are assembled in modular form; the 6 basic modules are those of acquisition and evaluation, storage, control, display, reduction, and initialization. (4 figures) (R.W.R.)

22454 (LF–44, pp 223–6) AUTOMATIC DATA PROCESSING SYSTEM FOR LONG-TERM TOXICOLOGICAL STUDY UTILIZING THE BEAGLE DOG. Redman, H. C.; Pratt, O. R. Jr.; Goodrich, R. M. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov 1971.

In Fission product inhalation program.

An automatic data processing system has been designed to facilitate the care and management of a colony of over 1,000 Beagle dogs which are utilized in long-term toxicological studies. The system operates on a Burroughs B-5500 Computer and provides scheduling and control of procedures for management of the dogs in addition to storage, recall, and analysis of clinical and laboratory data. The programs include scheduling of preventative medicine procedures, physical examinations (including radiography, electrocardiography and electroencephalography) and laboratory procedures, e.g., hemograms, serum chemistries, urinalyses and fecal flotations. A control on the completion of each procedure is maintained by the system. Data, entered daily, is processed and provides for periodic reports of inventory by assignment and location. These are made available to all investigators along with projected future schedules for efficient work planning. Any portion of the complete medical history is available on any dog or groups of dogs within an experiment (i.e., inclusive dates, selected procedures). (auth)

22455 (NP–18950) ANNUAL REPORT OF THE IDAHO NUCLEAR ENERGY COMMISSION REPORT NO. 4, 1970. (Idaho Nuclear Energy Commission, Idaho Falls). Dec 1970. 34p.

The physical research programs, education and communication activities, agricultural research, uranium and thorium mining, and industrial expansion are briefly summarized. The Western Interstate Nuclear Compact and expenditures since July 1967 are discussed. (C.E.S.)

22456 CONTROL OF X RADIODIAGNOSTIC INSTALLATIONS IN VIEW OF THE REDUCTION OF THE DOSE TO PATIENTS. Delhove, J. J. Belge Radiol.; 54: No. 6, 721–5(Nov-Dec 1971). (In French).

The radiation risk to human populations resulting from small doses of repeated radiations applies to a great number of patients and may not be entirely neglected. Recent publications have stressed this problem in estimating the probable increase in the number of mutations occurring in a population exposed to radiations. The new statutory requirements of Belgium (Royal Decree of 23-12-1970) require that approved organizations check all the diagnostic x-ray apparatus with a view to their approval by the Ministry of Public Health. The protection of the patient against unnecessary irradiation is to be taken into consideration. On the basis of experience acquired during practical controls, the various elements which influence the dose applied to the patient were determined. It was decided that better information supplied to the doctor concerning the objective to be attained and the use of techniques available at the present time may improve a situation which is not entirely satisfactory. (auth)

22457 RADIOPROTECTION IN THE DESIGN OF NATIONAL HEALTH REFORM. Pulcinelli, M. (Univ., Pisa, Italy). Minerva Fisiconucl.; 15: No. 2, 87–92(Apr-Jun 1971). (In Italian).

Article VIII of the D. P. R. No. 185 specifies the method of setting up a radioprotection service. This article is analyzed, and the structure of the service is examined. An alternative structure is considered. It is concluded that the D. P. R. No. 185 must be drastically modified and an alternative to the radioprotective service specified provided. (J.S.R.)

22458 IMPLICATIONS IN HEALTH PROTECTION OF THE BASIC NUCLEAR LAW OF DECEMBER 31, 1962, NO. 1860 AND OF THE D. P. R. OF DECEMBER 30, 1965, NO. 1704. Failla, L.; Nocera, F. (CNEN, Rome). Minerva Fisiconucl.; 14: No. 4, 197–201(Oct-Dec 1970). (In Italian).

Three years after its enactment the Italian nuclear law of December 31, 1962, No. 1860 was modified in parts by the decree of the President of the Republic of December 30, 1965, No. 1704. The purpose was to bring the basic law and the decree No. 185 of February 13, 1964 on protection into agreement and to remove certain applicative and interpretative problems. The applicative and interpretative problems are investigated. (tr-auth)

22459 (ANL–7881) SIMPLE INFORMATION RETRIEVAL SYSTEM BASED ON PL/I. Kraimer, M. R.; Clark, R. K. (Argonne National Lab., Ill.). Dec 1971. Contract W-31-109-eng-38. 37p. Dep. NTIS.

Miscellaneous

22460 (ANL-Trans–910) A HYDROGEN BOND OF TYPE F-H...O; THE CRYSTAL STRUCTURE OF K[PHO_2(OH)].HF. Altenburg, Horst; Mootz, Dietrich. Translated for Argonne National Lab., Ill., from Acta Crystallogr. Sect. B; 27: 1982–2186 (1971). 9p. Dep. NTIS.

22461 (AWRE-O–46/71) ION SELECTIVE ELECTRODES. PART 1. A STUDY OF THE FACTORS INVOLVED IN THE CONSTRUCTION OF A HETEROGENEOUS ION SELECTIVE ELECTRODE. Davies, A. B. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct 1971. 16p. Dep. NTIS (U. S. Sales Only). UK 13 pence.

22462 (BNL–16489) INHERITANCE OF 18-HYDROXY-DEOXYCORTICOSTERONE FORMATION IN GENETIC HYPERTENSION IN RATS. Rapp, John P. (Philadelphia Zoological Society, Pa. Penrose Research Lab. Pennsylvania Univ., Philadelphia. Dept. of Pathology); Dahl, Lewis K. (Brookhaven National Lab., Upton, N. Y.). [1972]. 27p. (CONF-711211–2). Dep. NTIS.

From twenty-sixth international symposium on high blood pressure; Philadelphia, Pa. (14 Dec 1971).

22463 (CEA-CONF–1880) DIFFRACTOMETRY BY MONOCRYSTALS POSSIBILITIES AND USE FOR CRYSTALLINE STRUCTURES. Bassi, G. C.; Guitel, J. C.; Geynet, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1971]. 11p. (In French). (CONF-710937–2). Dep. NTIS (U. S. Sales Only).

From International conference on x ray analytical methods; Toulouse, France (6 Sep 1971).

22464 (CEA-R–4129) FABRICATION AND STUDY OF OSMOTIC METALLIC MEMBRANES. Deschamps, Richard (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec 1971. 92p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Grenoble, France.

22465 (CEA-R–4194) WATER POLLUTION DIAGNOSIS BY HYDROBIOLOGICAL METHODS. APPLICATION TO HYDROGEOLOGY. Simeon, Claude (Commissariat a l'Energie Atomique, Pierrelatte (France)). Dec 1971. 158p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Bordeaux Univ. (France). Faculte des Sciences.

22466 (CEA-R–4222) BAEYER–VILLIGER OXIDATION OF BICYCLIC KETONES. STUDY OF THE REACTION MECHANISMS. Moutin, Michel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec 1971. 121p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Faculte des Sciences, Univ. of Grenoble, France.

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d'Etudes). Jan 1972. 110p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis.

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Thesis.

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From International symposium on proteins and nucleic acids; La Plata, Argentina (28 Nov 1971).

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22486 (KFKI-71-65) ORIGIN OF THE ASYMMETRIES IN THE QUADRUPOLE-SPLIT MOESSBAUER SPECTRA OF $FeCO_3$ /SIDERITE/. Nagy, D. L.; Kulcsar, K.; Dezsi, I.; Molnar, B. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1971]. 12p. (CONF-710947-2). Dep. NTIS (U. S. Sales Only).
From fourth international conference of the socialist countries on Moessbauer spectrometry; Dresden, Germany (20 Sep 1971).

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22490 (LBL-107) STUDIES OF GAS-SURFACE INTERACTIONS AT THE (100) CRYSTAL FACE OF PLATINUM BY MOLECULAR BEAM SCATTERING, LOW ENERGY ELECTRON DIFFRACTION, AND AUGER ELECTRON SPECTROSCOPY. West, Lloyd Albert (California Univ., Berkeley. Lawrence Berkeley Lab.). Nov 1971. Contract W-7405-eng-48. 277p. Dep. NTIS.
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22503 (ORNL-HUD-24(Vol.4)) DEMOGRAPHIC PROFILES OF THE UNITED STATES. VOLUME IV. THE WEST NORTH CENTRAL STATES. Lee, Everett S.; Levin, Martin L.; Pendleton, William W.; Postma, Patricia D. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 343p. Dep. NTIS.

22504 (ORNL-HUD-24(Vol.5)) DEMOGRAPHIC PROFILES OF THE UNITED STATES. VOLUME V. SOUTH ATLANTIC STATES. Lee, Everett S.; Levin, Martin L.; Pendleton, William W.; Postma, Patricia D. (Oak Ridge National Lab., Tenn.). Feb 1972. Contract W-7405-eng-26. 331p. Dep. NTIS.

22505 (ORNL-IIC-38) LIST OF AEC RADIOISOTOPE CUSTOMERS WITH SUMMARY OF RADIOISOTOPE SHIPMENTS, FY 1971. Curl, Ruth (comp.) (Oak Ridge National Lab., Tenn.). Feb 1971. Contract W-7405-eng-26. 34p. Dep. NTIS.

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Thesis. Submitted to Copenhagen Univ., Denmark.

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